A PARADIGM OF FACTORS THAT AFFECT THE USE OF THE COMPUTER AS AN INSTRUCTIONAL MEDIUM

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PREFACE

In trying to find a base for analyzing the lack of acceptance of the computer as an instructional medium, the writer found no adequate research or theory base available. Therefore, this research set out to create a basis for finding the reason or reasons for the lack of acceptance of the computer.

In the process of developing the questionnaire, a paradigm to describe the factors affecting computer use as an instructional medium was produced. This paradigm provides a basis for developing a theory of inhibitions in its most general sense. In a more limited sense, it can serve to detect whether teachers in a school system are likely to use the computer or not.

This dissertation presents a rough outline and start on the paradigm in Chapter I. Chapter II presents the literature from which the paradigm is developed. The third chapter summarizes the literature and presents the interview schedule. Chapter IV reports the case studies that were developed from the interviews. Chapter V contains a summary of the interview results and a presentation of the improved paradigm. Chapter VI presents the development of the questionnaire including its relation to the interviews and the paradigm. The last chapter includes a summary of the dissertation, implications of the research, and recommendations that resulted from this research.

I am deeply indebted to a great number of people who have helped to make this dissertation and the work leading to it possible. My father,

Troy Mosier, supported my undergraduate work and served as a motivating force in my education. My mother, Lora Mosier, was supportive of my educational aspirations and currently is providing work space for me. Dixie, Rebecca, and Rachel Mosier have been supportive and have given up much in order to support my work on this degree.

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Special thanks goes to Mary Huffman who has been my typist. She has done an excellent job of translating my writing into proper format for the draft copy. Thanks also to Elizabeth Banes who typed the corrections for the final copy. Cathy Patrick has also assisted with some of my rough drafts and the questionnaire.

However, the most important source of assistance has been my committee: Dr. Kenneth St. Clair, Dr. Gene Post, Dr. Carl Anderson, and Dr. George Hedrick. Without them, this work could not have been what it is.

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CHAPTER I

INTRODUCTION

Many studies have been made for the purpose of determining what can be done with the computer as an educational tool. Most of these have emphasized the use of the computer as an instructional medium. However, many of these studies have noted the poor usage of the computer in education and have given a variety of reasons for this (Feldhusen, 1970).

Other media have suffered this same syndrome of lack of use in spite of obvious value (Kanner, 1968). However, a search of computer and media literature revealed no attempt to determine the underlying factors for the lack of use, nor has there been any attempt to establish the relationships of these factors to each other and to the amount of use of the medium.

Acronyms abound in the computer field. In this paper, the acronym CAI will be used to refer to the use of the computer as an instructional medium in spite of the fact that it is usually used in the more restrictive sense of the use of the computer for the presentation of instructional materials.

Purpose

The purpose of this investigation is to develop a paradigm showing the relationships of the factors that affect the use of the computer in the classroom as an instructional medium. In doing so, it is necessary

to analyze the potential factors that indicate the extent of the use of the computer. In addition, it is necessary to determine from that set of potential factors a subset of factors that are most likely to affect the extent of the use of the computer in the classroom. After a paradigm is developed, the results must be validated through experiment and analysis in order to establish that they produce a useful paradigm. This study will not be concerned with the final validation of this paradigm.

Paradigm

A tentative paradigm of the factors that are related to the use of the computer and their relationships is shown in Figure 1. It was developed from readings and conversations with people interested in the application of the computer to instruction. Any of the factors which are shown to be insignificant during the study will be deleted. If any factors not yet considered appear to be of import to the paradigm, they will be added to the paradigm.

The main factor that will be used to indicate the amount of use of the computer in instruction is the amount of time that people involved in the instructional process make use of the computer. Essentially, this can be divided into the time used in the preparation of instructional experiences that use the computer, the time used by the teacher in using the computer in instruction, and the time used by the individual students or small groups of students in learning through the use of programs developed for instructional purposes.

Additional factors that indicate the amount of use of the computer for instruction are the number of students using the computer and the

- Amount
  - Time Used
    - Creation of Materials
    - Teacher in Classroom
    - Student Individually
  - Number of Courses
  - Number of Students
- Teacher
  - Support
    - Number of Computer Applications
    - Interaction Style
    - New Ideas
    - Ways Computer is Used
      - Instruction Types
      - Logic Complexity
      - Language Level
  - Attitude
    - Community
    - Administration
    - Peers
    - Students
  - Experience with Computer
    - Time Language Known
    - Number of Programs Written
    - Classroom Use Amount
- Administration
  - Support of Teacher
    - Money
    - Released Time
    - Resources Available
  - Support of Computer Use
    - Accessibility
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      - Assistance
      - Interaction with Computer
      - Operating Policies
        - Scheduling
        - Terminal Time
    - Amount Available in Computer
      - Size
      - Speed
      - Resources
        - Languages
          - Known
          - Possible
        - Programs Available
        - Storage Ability
        - Access Ability
        - Other Hardware

Figure 1. Tentative Factors Related to the Instructional Use of Computers.

number of courses in which the computer is used. The number of courses or subjects being taught using the computer indicates the breadth of the use while the number of student hours per course of computer use for instruction indicates the depth of the use.

Factors that may have an affect on the amount of computer use include teacher support of CAI, teacher attitudes toward the computer in education, administrative support of CAI, and the previous experience of the teacher with the computer. These factors are probably interrelated.

The teacher support of the computer in instruction may be reflected by the number of different applications in which they use the computer in their instruction, the style of the interaction of the teacher's programs with the student, and the new ideas that the teacher has for the use of the computer in instruction. At another level, the teacher support may be indicated by the ways in which the computer is used in terms of the computer instruction techniques utilized, the complexity of the logic of the computer programs, and the level of the language used for writing computer programs.

The attitude of the classroom teacher toward the computer is the main factor that will affect the use of the computer in the classroom. The attitudes of the teacher's peers, administration, and community as perceived by the teacher have a strong affect on the teacher's attitude. The attitude of the teacher is also affected by the students' attitudes.

The administrative support of the use of the computer will be reflected by the amount of money that the administration sets aside for use of the computer for instruction, the amount of released time that teachers are given for development of new instructional techniques, and

the resources that the administration makes available to the instructional staff. The support of computer use for instructional purposes seems to be a good reflection of the attitude that the administrator actually has toward the use of the computer in instruction. Indicators of support included the accessibility of the computer (Levien, 1974) to the teacher; the amount of work that can be done, without modification of the computer or support system, on the computer in support of instruction; and the time and money that are set aside for the teacher to use in creation of computer support of instruction (Levien, 1974).

The perception of accessibility deals with the ease with which any computer user feels he can design and implement programs on the computer. Factors that affect accessibility include the amount of time that it takes from presenting a program to the computer to getting the results, the amount of assistance there is for preparing and correcting a program for proper execution, and the ease with which the teacher can describe the job he wants to do so that the computer can understand it (language). The operating policies of the computer administration also affect the accessibility factor. The two main factors affecting teacher-student accessibility here are the method of scheduling jobs to run on the computer and the amount of terminal time available per student in the school.

The amount that can be done on the computer for instruction should be compared with the amount that is actually done for instruction and the possibility that this difference can go to instruction. Factors that affect the amount possible are the size of the computer, its speed, and the additional resources available. These resources include the computer programming languages that are known by the teacher and

those that are possible for the teacher to learn. The resources also include the computer programs that teachers feel are of use in instruction that are available on the computer. Finally, these resources include storage ability, access ability, and hardware supplies that are available and are useful for instruction.

In addition to the factors of attitude and support, the previous experience that the teacher has had with the computer may affect the amount that the computer will be used in the classroom. The experience of the teacher is indicated by the amount of time that the teacher has known a computer language, the number of computer programs that the teacher has written, and the extent to which the teacher has used the computer in the classroom.

Definitions

There are many acronyms used in referring to the use of the computer in education. The most popular is CAI (Zinn and McClintock, 1970). Others that are very popular are CBI and CMI. Still others being used include CEI and CSI. All of these terms refer to the use of the computer to support the instructional process. They differ according to the way in which the computer is used for support of instruction.

CAI—is Computer Assisted Instruction in which the computer is used as a presenter of instructional material to the student.

CBI—refers to Computer Based Instruction in which the computer is used as a resource, source of material, source of data analysis, or a tool for the student. This is a general term that can include all the others.

CEI—refers to Computer Extended Instruction (Wright, 1972) in which the student learns to program and uses the computer as a learner to which the student teaches certain subject matter. In addition, CEI includes the use of the computer as a computation device to illustrate concepts that are not otherwise possible in the classroom.

CMI—is Computer Managed Instruction in which the data that have been stored about a student and the data about the subject matter he is to interact with (not necessarily on the computer) are analyzed by the computer in order to recommend what the student should interact with next.

CSI—is Computer Supplemented Instruction (Allen, 1972a). In CSI, the machine acts as a supplement to regular teaching, to drill and possibly test students on material they have learned elsewhere.

Related Literature

There are many advantages and arguments for the use of the computer in support of the instructional process. According to Woodson (1973), the arguments for the effectiveness of the computer as an instructional tool include individualization of instruction, immediate feedback, and the collection of data about the effectiveness of instruction. Abelson (1972), in his review of The Fourth Revolution (1972), notes that the advantages for the use of expanded technology in instruction are: it increases the opportunities for independent study, it offers a rich variety of courses and methods of instruction, it is tolerant and patient, and it offers possibilities for off-campus instruction, Dwyer (1971) notes a different set of advantages of using computer technology. These include: (1) the computer systems don't

"know" that they are supposed to become depressed by their surroundings, and (2) the genuine complexity of such machines (computers) gives them great flexibility.

Feldhusen (1970) lists five things which CAI will be able to do better than other instructional media. CAI can process information about the students' performance in order to determine subsequent activities. CAI can store large amounts of information. CAI can provide programmed control of several media. CAI is a convenient technique for designing and developing a course. Finally, CAI can provide a dynamic interaction between the student and the instructional program.

Scrivens (1969) feels that most CAI programs produced greater achievement than other media and that student attitudes were changed in a positive direction through the use of CAI. He also notes that teachers employing such techniques were freed from some routine classroom chores and had more time available to them.

Suppes' (1969) results indicate that the computer-based courses held the interest of the students much better than the regular courses. He also notes that the use of computers in instruction can bring a kind of quality control that is difficult to achieve in large numbers of schools with large numbers of teachers. He goes on to say that many teachers would prefer to turn the problem of providing a regime of review and maintenance of arithmetic skills over to a computer. Suppes concludes that the possibility of bringing enriched programs to students in a variety of environments where such courses cannot reasonably be offered by the teaching staff is probably one of the most immediately practical products of computer based courses.

Brown (1969) feels that the computer's almost unlimited capacity to store information makes it an ideal "teaching machine." He says that the job of the future is to do better in efforts to facilitate all kinds of student learning and that the computer may be the ideal helpmate in this task.

In spite of these advantages and others that the computer can bring to the instructional process, the instructional use of the computer has not yet developed beyond the research phase. Zinn (1968b) notes that the benefits unique to computer presentation and control have not yet been demonstrated. He goes on to say that few lesson designers had made use of capabilities beyond those which can be accomplished with the printed format. McMullen (1974) notes that the tendency to revert to machine-driven programmed instruction poses a continual problem for future research.

However, the computer has shown possibilities for contributions to the instructional process. The management of instruction, enrichment of instruction, quality control, reduction of teacher load, and the possibility of dynamic interaction are but a few of these.

Why has the computer not been accepted in the schools as well as is indicated by these arguments and possibilities? Many explanations have been offered starting with the cost of computing equipment and quickly turning to the cost of curriculum design and validation (which includes costly professional programming) (Hickey, 1968b). The lack of programming languages that are convenient for specifying interactive instruction is also noted (Frye, 1968).

According to Rogers (1968), difficulties are encountered when a computer system is installed to do part of the job and the responsibility

to do the rest of the job is left up to teachers who are less than adequately prepared to apply the computer's results to their everyday classroom practices. He goes on to say that the formal educational establishment tends to produce a smaller portion of instructional materials than it consumes, and relies instead for the bulk of its needs upon the textbook publishers and upon the manufacturers of supplementary materials. He feels that a major obstacle to the sucessful application of CAI is the lack of quality course materials.

Zinn and McClintock (1970b) say that much of the material developed makes little use of the essential computer contributions; some of it would be as effective and certainly less expensive in another mode. They further note that the contribution of CAI to the development of a theory of instruction (and vice versa) has been questioned. They also feel that today's educational problems will not be solved by the introduction of CAI on a massive scale. They also feel that guidelines for developing instructional systems to respond to individual differences have not yet been developed.

Stolurow (1969) places the blame on the profession's meager knowledge of how to teach and the lack of an empirically validated theory of teaching. Allen (1972a) notes that there have been too many programs written which only automate bad teaching. McMullen (1974) says that it is generally agreed that CAI tends to automate earlier techniques. Kopstein (1968) feels that the main obstacles to the evolution of CAI are questions of instructional strategy and tactics.

Feldhusen (1970) says that the growing pains of CAI are evidenced by excessive theoretical speculations, unrealistic speculations, poor quality of materials, and a tendency to be overly concerned with

computer hardware and systems. Disadvantages of terminals, according to Hedges (1973), are that the machines are noisy; machines do break down, especially at awkward times; the faculty is usually not trained to use them; the costs are still high; and good programs are scarce.

Need for the Study

Studies of Computer Assisted Instruction, Computer Based Instruction, Computer Managed Instruction, Computer Extended Instruction, and Computer Supplemented Instruction, as well as any other use of the computer in instruction, place an emphasis on the development of hardware and software by a team of experts for use in the instructional process. Many of these studies lament the lack of use of the computer in education. This study should present some of the factors, along with their relative importances to the process, that are related to this lack of use of the computer in the educational process.

Of course, the literature contains many explanations for the failure of the computer to gain wide acceptance as a classroom medium (Hickey, 1968b). However, there apparently has been no attempt to determine the relations that these various factors have to actual schools and their environments. This study should provide some idea about the relationships among a group of factors affecting the amount of use of the computer for instructional purposes and a group of factors that affect the amount of use of the computer in the classroom.

The results of this study will provide a paradigm that should be useful in determining methods for encouraging the classroom teacher to use the computer. After this paradigm has been tested, it will be used as an aid to the implementation of the computer in instruction.

It will also serve as a resource in the development of a theory for the implementation of any new medium in the classroom.

Design

The factors presented in the paradigm section of this chapter will be used as components of a tentative paradigm which will be refined through case studies by the experimenter of the use of CEI in the Wichita, Kansas Public Schools and the use of CBI in the Shawnee Mission, Kansas Public Schools. The case studies will be developed from interviews with teachers in the schools who have used successfully, have used unsuccessfully, have decided against using, or want to use the computer in the instructional process. In addition, the people who are responsible for the computer activity will be interviewed.

The interview used in these case studies will be developed from a tentative paradigm developed from readings and informal conversations. The interview will also seek to detect problems in the paradigm and to determine whether any factors have been overlooked. After the case studies are completed, the paradigm will be corrected by those things discovered in the case studies.

Conclusion

There is considerable interest in the use of media in education. One of these media is the computer. However, the computer is not yet fully accepted as a medium and is not used to any notable extent in education.

The main reason given for this lack of use is the high cost of computers and high cost of support for computing. This is well illustrated by Oettinger (1969) when he says that "the notion that any form of technology can make a significant contribution 'at no additional cost or even at lessened cost per pupil' is an illusion. More books and better libraries--cost more money. Greater individualization costs more money, no matter what the specific process may be. Better understanding and better trained people cost more money" (page 194). However, there has not been any attempt to find the other factors affecting computer use in the classroom and their relationships for the purpose of overcoming the discouraging effect of the cost factor.

This research is intended to provide a start toward overcoming the lack of use of the computer for instructional support in order to improve the quality of education and enrich the educational process.

CHAPTER II

RELATED LITERATURE

There are few studies which have dealt with the factors that affect a teacher's decision to use or not to use an instructional medium. Even fewer have dealt with the computer as a medium in this context. Many authors have noted in passing some factors that they feel affect the use of the computer as an instructional medium. The bulk of this review will present those factors.

This review has four parts. The first is introductory and contains the studies dealing with factors affecting the use of the computer in instruction. The second presents positive factors while the third presents negative factors and the fourth presents solutions suggested for negative factors. In Chapter III these factors are used to create the paradigm.

In 1968, Andrews performed an analysis of the attitudes toward the computer and data processing. The concepts he used were: computer grade reporting, computer cards, data processing, identifying people by number, Computer Assisted Instruction, computerized scheduling and efficiency of data processing. He found positive attitudes for all school personnel, although they defined the concepts differently according to the role that they held in the school.

In 1969, Christopher published a study on the influence of a CAI experience upon attitudes of school administrators. He found that the

use of a computer instructional unit caused attitudes to become more favorable and expressed apprehension to decrease. He also found that the more knowledgeable administrators had a more favorable attitude and that there was more change in administrators who were less knowledgeable.

In 1971, Fagan published a study on the effect of teaching strategies on cognitive and affective responses of pre-service teachers toward computers. He found that there was a positive correlation between the gain in knowledge and positive attitude. He also found a negative correlation between the attitude toward CAI and the gain in knowledge.

In 1972, Anastasio published a study of factors inhibiting the use of computers in instruction. He presented the manifestations, explanation, and categories of inhibitions as well as the study technique (Delphi) and questions that were used in the study. His conclusion was that there exists a circular problem in which demonstrations require money, but money sources want demonstrations in order to support further development. Another 1972 study, by Ellson, was designed to find out how aware and how prepared the schools in California were to use CAI. He concluded that demonstrations of use, financial assistance, careful planning, and more research were needed.

Although these studies deal with acceptance of the computer, they do not use nor develop a general structure which can be used in the analysis of the results.

Positive Values

In this section, only the positive statements about the use of CAI

will be presented. The problems and their solutions are held for later sections. The bulk of the positive statements were that individualization can be enhanced or carried to its extreme using the computer. Many refer to the rich potential that the computer provides. A few present the computer as the solution to all educational problems.

Scrivens (undated) said that evaluation of CAI projects indicate significant improvement over traditional instruction. In 1965, Armer presented possibilities for the computer which include: clerical and information handling (see also Suppes, 1965; Suppes, Jerman, and Brian, 1968; and Suppes, 1968), increased student productivity, and research and development in education (see also Atkinson and Hansen, 1966; Zinn, 1967a; Hagen, 1967; Stolurow, 1969a; Feldhusen and Szabo, 1969a; Charp, 1970b; and Zinn and McClintock, 1970b). Stolurow and Davis (1965) presented the reasons that the computer is the best teaching machine which include: the versatility of the response accomodation, the richness of evaluation criteria possibilities, the richness of the selection functions possible, and the variety of displays that are possible.

Also in 1965, Suppes said that computer technology provides the only serious hope for providing for individual differences (see also Dick, 1965; Suppes, 1966; Wing, 1966; Filep, 1967; Herbert, 1967; Bitzer, 1968, Hickey, 1968c, Di Lorenze, 1968; Suppes, Jerman, and Brian, 1968; Suppes, 1968; Atkinson and Wilson, 1968; Gerard, 1969; Fejfar, 1969; Bitzer and Boudreaux, 1969; Charp, 1970b; Coulson, 1970; Hall, 1970; Hansen, 1970; Computer Assisted Instruction: A General Discussion and Case Study, 1971; Selzer, 1971; Yeo, 1972; Hedges, 1973; and Dunn and Morgan, 1974), relieving the teacher of record keeping

duties (see also Goodlad, O'Toole, and Tyler, 1966; Bitzer, 1968; and Anderson, 1968), and gathering research data (see also Atkinson and Hansen, 1966; and Gerard, 1969). In January of 1965, Dick saw the computer as an unlimited area of research.

In 1966, Goodlad, O'Toole, and Tyler presented factors they felt were promoting the use of computers in education which include: too few qualified personnel available (see also Hickey, 1968c; and Kopstein and Seidel, 1968), many groups are making demands for more data (see also Rogers and Cook, 1966), efficiency is being sought (see also Block, 1970; and Lyons, 1970), and the computer can be responsive to the environment.

Also in 1966, Rogers and Cook said they felt that schools of tomorrow would rely on computers for their routine paperwork (see also Suppes, 1968; Bitzer and Boudreaux, 1969; and Yeo, 1972) due to the demands on the teacher in terms of paperwork increase while overall demands also increase. They also discussed the applications of computers for scholastic purposes such as producing worksheets, diagrams, tables, graphs, maps, etc., and reproducing them in the desired form.

In July of 1966, Oettinger said that the student may use computers not only as sources of information (see also Poteet, 1968; Gamble, 1969; Coulson, 1970; Leonard, 1970; and Feldhusen, 1970) and for problem solving (see also Coulson, 1970; and Zinn, 1970b), but also as tools for remembering techniques that the student has used to solve the problems. The computer system could thus be regarded as a crude beginning of a social memory. He felt that a system of remote storage of data might make control over materials easier (see also Atkinson and Hansen, 1966).

In September, Suppes (1966) noted that the computer can adapt mechanical teaching routines to the needs and past performance (see also Bitzer, 1968) of the individual student. He presented some ways in which the computer could be used in education such as: collecting systematic data about the success of students, giving tests (see also Zinn, 1969a; and Hedges, 1973), and for drill and practice functions (see also Poteet, 1969; Zinn, 1970b; and Hedges, 1973). His argument for CAI goes like this: it is widely agreed that the more the educational curriculum can adapt to individuals, the better the chance of providing successful learning. The computer makes individualization easier because it can follow the student's history.

In November, Wing (1966) presented types of individualization which included: variation of pace (see also Filep, 1967; and Bitzer and Boudreaux, 1969), variation of scope, easy content variation, variation in presentation style, variation in mode of presentation, sequence variation, and variation in the difficulty of problems presented. In the fall, Atkinson and Hansen (1966) gave the reasons for CAI reading research which include: establish long run feasibility, demonstrate a school based laboratory for research and development, provide more precision of response recording (see also Teates and others, 1970), and allow rigorous behavioral measures.

In 1967, Richards said that the computer extends the resources of the central nervous system much like other tools have extended other human abilities. In January of 1967, Suppes listed the following uses for the computer: the presentation of special topics to abler students, the provision for selected topics in smaller and/or rural schools, and patient (see also Pfeiffer, 1968; and Anderson, 1968) and intensive

(see also Leonard, 1970) work with some of the very slow students (see also Bitzer, 1968; and Bitzer and Boudreaux, 1969). He noted that at present there is no feasible alternative to CAI in sight for solving these problems. In February, Dorn (1967) presented computer extension of instruction (CEI) (see also Wright, 1972) as a use of the computer in schools and went on to present examples of its use in this mode.

Filep (1967) discussed the potential of the computer for mass education (see also Block, 1970) and individualization of instruction. The characteristics he lists as making the computer good for furthering mass education are the traits of interaction (see also Herbert, 1967; Feldhusen, 1970; and Hess and Tenezakis, 1970), presentation of instructional sequences based on prior responses and available history (see also Anderson, 1968), diagnosis of weaknesses in skills and abilities (see also Charp, 1970b; Readings in Computer Based Guidance, 1970; and Yeo, 1972), and the ability to employ different media (see also Poteet, 1968; and Zinn, 1969a). He said that CAI has considerable value due to multiple access, on-line, and time-shared systems.

Bitzer (1968) said that the computer can be used to encourage critical thinking skills (see also Bitzer and Boudreaux, 1969), and for computation (see also Oldehoeft, 1971). The attributes he gave for individualization include: immediate feedback (see also Bitzer and Boudreaux, 1939), and complex internal branching (see also Bitzer and Boudreaux, 1969). Di Lorenze (1968) states that both CAI and CMI are potent avenues to individualization. Also in 1968, Suppes, Jerman, and Brian said that the major aspects of CAI potentially include attention to the student and information flow.

In April of 1968, Suppes argued that the computer supplies unlimited possibilities for diversity (see also Oettinger, 1968; Bork, 1969; and Leonard, 1970). He also argued that the source of the threat to individuality and human freedom is human. Also in April, Atkinson (1968) said he sees CAI as the catalyst for new concepts of learning theory (see also Stolurow, 1969a) and a theory of instruction. In May, Oettinger (1968) noted that the advantage of the computer over the tutor is the amount of control that can be exercised (see also Papert and Solomon, 1972).

In the spring, Poteet (1968) included a fairly long and detailed list of possible uses for the computer for the teacher of English. Some of these include: improving skills, access to library resources, linguistic analysis, grading, inventory, scheduling use and maintenance of supplies, analysis of effectiveness and durability of materials, census of interests, directories, identification of underachievers and pupils with special needs, and statistical analysis. He concluded that the English teacher needs to think of the computer as a way of improving communication. In the summer of 1968, Kopstein and Seidel said they felt that the costs of CAI would fall drastically (see also Lyons, 1970; Nyquist, 1972; and Tennyson, 1974).

In October of 1968, Anderson presented the state of the art for CAI. As a prescriber (see also Feldhusen, 1970), the computer could access the student's background and current status in order to select the best material from what is available. As a teacher (see also Christopher, 1968; Lyons, 1970; Hess and Tenezakis, 1970; and Allen, 1971), the computer could keep records of how well the materials have been received by the students. He concluded that the promise is

exciting (see also Atkinson and Wilson, 1969; Block, 1970; and Baker, 1975) and the feasibility has been demonstrated (see also Feldhusen and Szabo, 1969a; Feldhusen, 1970; and Young, 1972). Atkinson and Wilson (1968), in October, presented what they felt the rate of growth of CAI was due to, which included: the growth of programmed instruction (see also Atkinson and Wilson, 1969; and Holland, 1971), the growth of electronic data processing (see also Atkinson and Wilson, 1969), and the aid of the Federal Government. They felt that there was a large variety of applications (see also Atkinson and Wilson, 1969; and Zinn, 1970a) which included possible optimization of the learning process.

Atkinson and Wilson (1969) noted the factors that affect the rate of growth of CAI. These include the potential aid to education that it could provide. Gerard (1969) presented the major gains from computer records. For the educator, the micro-record allows easy experimentation. For the student, the learning record helps in finding out how he learns (see also Bitzer and Boudreaux, 1969; and Papert, 1970), and performs certification of mastery (see also Hall, 1970). Stolurow (1969c) saw CAI as the formalization of teaching theory (see also Knezovich and Eye, 1970) which makes validation of teaching theory possible.

In 1969, Bell and Moon said that present CAI systems have been justified in terms of special applications, experimentation (see also Zinn, 1970b), and examples of exceptional learning with CAI. They conclude that increasing use of computers in society makes knowledge of computers increasingly important. Also in 1969, Brown, Lewis and Harcleroad said that the computer may be an ideal helpmate in the

task of doing better in our efforts to facilitate all kinds of student learning (see also Negroponte, 1969; Porter, 1970; Smith, 1971; Allen, 1971; and Oldehoeft and Conte, 1971).

In Cristopher (1969), the findings include that a computer instructional unit caused attitudes toward the computer to become more favorable (see also Selzer, 1971; and Baker, 1975), and decreased expressed apprehension. Gamble's (1969) discussion presented the following advantages to using the computer: rapid and objective manipulation of large amounts of data (see also Coulson, 1970), probability predictions, and identification of alternate choices. He noted that, in addition, information of entire libraries may be stored and drawn upon when needed by the computer (see also Coulson, 1970). He said that instruction by computer is a part of the method of aiding high risk students.

Hansen and Harvey (1969) noted that the computer will affect the role of the teacher (see also Hess and Tenezakis, 1970); a series of role changes are presented. They saw less presentation of information and more managerial and strategy functions for the teacher, greater involvement in guiding the student, wider ranges of discussion techniques being employed by teachers, a greater array of differentiated professional joining in order to develop and present materials, and more diagnostic assessment and prescription for the student by the teacher.

Stolurow (1969b), said that although CAI is no panacea, it is a substantial innovation. Zinn (1969a) said that the contributions that the computer should make to instruction are: prompt evaluation of student responses, automated feedback (see also Hall, 1970; and

Oldehoeft and Conte, 1971), summaries of performance for the teacher and the author, complex instructional strategies, teacher adaptation of materials, and author aid for revising the materials (see also Feldhusen, 1970; and Starks, Horn, and Slavens, 1972).

In January of 1969, Gordon said he felt that the computer should be capable of performing arithmetical functions, text manipulation, line drawings (see also Papert and Solomon, 1972), and simulation (see also Charp, 1970b; Zinn, 1970b; Papert and Solomon, 1972; and Hedges, 1973) for both the teacher and the student. He said that the virtue of the computer is that it enables different things to be done in the classroom.

In April of 1969, Bork said he felt that the computer has considerable intuitive value for education. Conaway (1969) said that the computer's ability is limited mainly by the resourcefulness of the user. He went on to say that unless high schools and colleges start telling their students how their lives will be changed by computers (see also Charp, 1970a), they are selling both computers and their students short. Feldhusen and Szabo (1969a) said that CAI has grown rapidly and shows promise for applied instruction.

Also in April, Negroponte (1969) discussed the possibilities of humanism (see also Thomsen, 1970; and Dwyer, 1971) through the use of machines. In this article he said that the transition from a "computerized environment" to a "computer aided" environment will enable designers to have a dialogue with their new design partner, the computer.

Early in 1969, Bitzer and Boudreaux said that the computer material they used provided flexibility, allowed the student maximum

control over direction, encouraged open-mindedness, and allowed constructed responses using natural language. Their study indicated that computer based education provided unique features which make it ideal for training in general cognitive skills. In terms of lending stability to the instructional process, more is taught effectively (see also Computer Assisted Instruction: A General Discussion and Case Study, 1971).

In 1970, Block said that CAI makes education more scientific, provides top flight instruction to large numbers of people, and is a more efficient operation of the schools. She concluded that "at present, it is almost the case that CAI's potential is its justification" (p. 42).

Charp (1970b) presented the introduction to a bibliography of computers and education by Van der Aa (1970). In it she said that the potential of computers includes managing instruction. Coulson (1970) presented the following applications for instructional assistance by the computer: tutoring, and data management aid for the staff and administration in instructional planning (see also Seltzer, 1974).

Also in 1970, Leonard said that computers will be able to understand students' responses in written or spoken form. He felt that central school computers can also help keep track of students as they move among activities. Leonard also felt that this will wipe out even the administrative justification for schedules and regular periods.

Duhl (1970) said that it is possible to amplify man's powers through tools, but these tools also modify social integration (see also Hess and Tenezakis, 1970). He felt that education is increasingly being offered in areas where we feel that the family has failed. Further, he

saw technology providing education where the teacher fails to provide it. Martin (1970) said that the computer is the instrument that can call for multisensory adaptation to a multimedia presentation (see also Feldhusen, 1970). Thomsen (1970) noted that the computer is reaching new groups of people. He felt that the computer would be reaching new groups and that the effects would be felt outside the existing formal structures of education.

Feldhusen (1970) presented some things that CAI will become able to do better than any other medium. These include: secure, store and process information (see also Readings in Computer Based Guidance, 1970; and Zinn, 1970b).

Hess and Tenezakis (1970) presented the computer as a socializing agent. The properties that they found that CAI has as a socializing agent include: reinforcement (see also Holland, 1971), motivation and management (see also Porter, 1970; and Yeo, 1972), and part of the school authority structure. The implications were that the computer does more than transmit information; and the students may come to appreciate the machine as a source of information. Their findings were that the lack of discrimination may make CAI useful in helping certain children learn skills for relating to the teacher, and the image that students have seems to come more from their environment than from the interaction with the computer.

In Readings in Computer Based Guidance (1970), ways in which the computer can be used in guidance and counseling were presented. These include: instructional gaming and synthetic confrontation therapy. The conclusion was "if man can avoid becoming the tool of his tools, then maybe together, we can do a hundred things we never dreamed of" (p. 23).

A paper by Teates and others in 1970 presented the computer as a tool for formative curriculum evaluation. They felt that the use of CAI in designing instructional materials was potentially the most appropriate and efficient use of monitoring progress in order to create supplementary materials for the ISCS program. Zinn and McClintock (1970a) presented a guide to interactive use of computers for instruction in 1970. In it they noted a trend to giving the student control.

In the winter of 1970, Dwyer and Critchfield noted that the real educational role of technology makes the educational process less machine-like. Early in 1970, Kaimann (1970b) saw the computer as a valuable asset to the learning process. He said that it is a means to the end of gaining insight but it must not be construed as an end in itself. In March, Grayson (1970) noted that CAI groups had been shown to perform as well or better on standardized examinations, and have a comparatively lower drop-out rate than traditional instruction. His worries were about the relevance of the present education system and its depersonalization as well as the costs of education. He felt that computers hold forth promise of that solution. He said that CAI is often touted as the answer to the educator's dream of continually reshaped instruction inexpensively. Also in March, Zinn (1970a) noted that two of his predictions from 1964 came true. His first was that the variety of uses or modes of use would surpass what he could predict. The second was that time-sharing would become more available and all who wanted trial experience could have it.

In August of 1970, Zinn (1970b) noted that the computer was being used for modeling, recording and analyzing data, and in building

models. In the fall of 1970, Siklossy noted that computers were suited for bookkeeping (see also Computer Assisted Instruction: a General Discussion and Case Study, 1971).

Computer Assisted Instruction: A General Discussion and Case Study (1971) presented the advantages of CAI which include: it requires less instructional time, it provides safety and expedience, and it increases the quality of training (see also Molnar, 1971).

Also in 1971, Heller presented a graphical representation of music which uses the computer as a portable music synthesizer. He noted that the music student's hurdles, which are learning music notation and developing a technique on some musical instrument to provide a medium, are overcome through the use of the computer.

Holland (1971) noted that certain tasks in programmed instruction can only be performed by computer. An example was differential reinforcement contingencies. He reported that the computer has successfully managed reinforcement contingencies. Another 1971 paper, by Molnar, discussed the future of educational technology research and development. In it he noted that the computer offers an alternative that can significantly affect the availability of education. Technological Augmentation of Human Cognition: An Interdisciplinary Review (1971) noted that the technical augmentation of cognition extends and complements the human mind's natural learning skills.

In April of 1971, Allen described his preliminary conclusion concerning learning French using CAI which included: CAI will not take the place of the language laboratory. Also in April, Seltzer (1971) noted that the freeing of the teacher is an advantage that CAI provides. In October, Oldehoeft and Conte (1971) felt that the computer

overcame at least the following problems of the conventional student: time spent debugging limits computational experience, and student input in creation of algorithms is not feasible.

The Fourth Revolution: Instructional Technology in Higher Education (1972) noted that the computer must eventually stand as but one of many techniques and that it is now considerably underdeveloped.

In April of 1972, Papert and Solomon described innovative things that the computer terminal called the Turtle can do. In the summer of 1972, Yeo noted that the student can learn at least as well as with traditional instruction, and that the computer can serve as a diagnostic and directive resource as well.

In March of 1973, Woodson said that the use of computers for CAI holds promise of teaching us more about how to conduct instruction. In November, Hedges (1973) discussed computer functions which include: encourage the student to develop strategies, student competes with himself, encourage and cultivate creativity, allow the student to study anything he wants, self improvement of information, test item pools, entry of computer runs, and guidance.

In January of 1974, Seltzer discussed what the person who develops a CAI program gains from CAI. The mentor realizes how disorganized his course really is. The programmer learns the intricacies of the material and a perspective of the subject. The instructor learns about the organization of his subject matter. He concluded that the people who are instrumental in developing the CAI materials often profit more from the experience than the students who use the results.

In 1975, Baker said that the positive side of using the computer includes: designing your own programs and information exchange. She

concluded that the computer is a tool to be used. It will remain idle until it is activated by a person who has found a use for it.

Problems

This section will deal only with those statements which are considered to detract from using the computer for instructional purposes. The positive side has already been presented and the implementation requirements will be presented in the next section. Cost is the main factor mentioned. The main other factors mentioned are lack of imagination and excessive speculations. The early phase of development that exists due to the newness of the medium as well as the lack of adequate theories are also mentioned by a variety of authors.

In 1961, Carter noted that one of the most difficult problems in automated teaching is the writing of good instructional materials. In April of 1963, Bushnell pointed out that educational philosophers cannot agree as to what behaviors should be taught.

In 1965, Suppes discussed the problems that he saw which include: possibility of stimulus deprivation, high costs (see also Goodlad, O'Toole, and Tyler, 1966; Chorvinsky, 1967; Zinn, 1967a; Strum and Ward, 1967; Molnar, 1968; Suppes, Jerman, and Brian, 1968; Silberman, 1968; Anderson, 1968; Dick, 1969; Molnar, 1969; Block, 1970; Margolin and Misch, 1970; Hall, 1970; Grayson, 1970; Kaimann, 1970a; Computer Assisted Instruction: A General Discussion and Case Study, 1971; Hansen and Johnson, 1971; Rudolph, 1972; Anastasio, 1972; Yeo, 1972; Forcier and Grant, 1973; McMullen, 1974; and Baker, 1975), and the temptation to settle for less than the best curriculum in order to avoid problems.

In 1966, Goodlad, O'Toole, and Tyler presented the factors which they felt were hampering computer technology which include: it is an unknown world for educators, it is not seen as humanizing (see also Suppes, 1968; Grayson, 1970; and Yeo, 1972), lack of knowledge of the potentialities, and poor dissemination of the results (see also Allen, 1972). They also noted a shortage of personnel in schools that were qualified to operate EDP systems.

In July of 1966, Oettinger said that it was conceivable that terminals located in the home could lead to problems of addiction and competition. In December of 1966, Hansen said he felt that natural language processing is a problem (see also Strum and Ward, 1967; Silberman, 1968; Silberman, 1969; Jerman, 1969; and Uttal, 1969) and that considerable psychological research needs to be done.

In 1967, Chorvinsky noted the following limitations for CAI: organizational principles, and few people know both the computer and education (see also Forcier and Grant, 1973). Richards (1967) noted that as so often happens, the new means have rapidly overtaken the original needs that called them into being. The problems he presented for CAI include limitations of the computer itself (see also Gentile, 1967; Rogers, 1968; Atkinson and Wilson, 1968; Atkinson and Wilson, 1969; Dick, 1969; Uttal, 1969; Block, 1970; Hunka, 1970; Grayson, 1970; and Becker, 1971). He noted that the teacher teaches as he was taught (see also Bushnell, 1970) and that early attempts will seek to do with the computer just what has been done traditionally (see also Papert, 1970; and Allen, 1972). Zinn (1967a) noted the factors in the debate over the value of the computer which include: distribution, reliability (see also Suppes, Jerman, and Brian, 1968),

ease of use, relevance, richness, effectiveness, and facilitation of research.

Wodtke, Brown, Sands, and Fredericks (1967) raised some question that the approach to instruction which places a strong emphasis on optimal course sequencing, small step programs, minimal error rates, etc., has value (see also McMullen, 1974).

In February of 1967, Dorn noted the shortcomings that he felt the computer had for computer science in high school which include: the more complex problems require digressions to fill the student in on the concepts or statements of mathematical ideas with no substantiation, little intellectual depth is possible, and the problems that are assigned could be solved just as easily with pencil and paper.

In March of 1967, Strum and Ward said they were disillusioned because of the poor man/machine communication, the inability of the system to interpret student answers, the effort required for preparation of materials, and the cost of hardware and preparation.

In the spring of 1967, Gentile noted the following CAI communications problems to be solved. Programming has arisen as the main technical problem. The main semantic problem is meaning which deals with individual differences (see also Hansen, 1970) and computer languages. The main effectiveness problem is the effect on conduct in the desired way which still lacks systematic attacks (see also Hansen, 1966).

In 1968, Becker said that we need to understand the problems of reality. Change in education is apt to be evolutionary (see also Richards, 1967; Stolurow, 1968; and Silberman, 1968) because: technology is felt to be in competition with the role of the teacher, both

teacher and technology promise more than they can deliver (see also Rodgers and Cariglio, 1968), the majority of educational institutions are designed for stability, and rapid change costs too much. Society gets pretty nearly what it wants, according to Becker; just good enough. The city's public schools are no better than the people who control the money and power want them to be. History indicates, Becker said, that the schools couldn't spend the money wisely if they could get it. He concluded that education is too complex to admit to anything like systems analysis.

Goodman and Gould (1968) presented the following problems of CAI: lack of software (see also Anastasio, 1972), lack of evidence that any software will be available, and CAI is in the research and development stage (see also Di Lorenze, 1968; Roth, 1969; Kropp, 1970; Johnson, 1971; and Suppes and Morningstar, 1972). Kurland (1968) said that the major problem in CAI development at present is the lack of adequate theories (see also Hickey, 1968; Stolurow, 1968; and Anastasio, 1972) or readily validated experience (see also Molnar, 1968). Molnar (1968) felt that invention has become the mother of necessity rather than the other way around. He then said that we in education believe strongly in local autonomy (see also Molnar, 1969), but that cost trends make technology most economical on a regional or national basis. He added that copyright laws are needed and concluded that what is required is a reevaluation of our social assumptions (see also Hickey, 1968).

Silvern (1968) noted that the mere presence of the computer is not sufficient for it to be used for education support. Stolurow (1968), complained that the systems are not being used imaginatively (see also Charp, 1970; Suppes, Jerman, and Brian, 1968; Martin, 1970;

Seltzer, 1971; Yeo, 1972; and Suppes and Morningstar, 1972), and that they are internally rather than externally sophisticated. He went on to say that the development process should not be a "one shot" demonstration which he felt had been done (see also Mesthene, 1970). Suppes, Jerman, and Brian (1968) noted problems that show up in CAI programs which included the exhibition of stimulus deprivation.

Early in 1968, Silberman noted problem areas of implementation which include user acceptance (see also Silberman, 1969). In terms of man-machine communications, the language is not appropriate (see also Frye, 1968). In terms of cost effectiveness, the materials are incompatible for transfer (see also Molnar, 1969), it is difficult to calculate benefits, and comparisons of CAI with other methods have not yet been favorable. In terms of user acceptance, there is a lack of involvement, and there is a lack of effective staff training programs in which acceptance could be developed.

In April of 1968, Atkinson noted that few of the reports of CAI were based on substantial research and experience. The majority of the reports were vague conjectures and speculations (see also Mesthene, 1970). He went on to say that for too long psychologists studying learning have shown little interest in instructional problems whereas educators have made only primitive and superficial applications of learning theory. Also in April, Suppes (1968) said the problems that he saw being presented concerning CAI include: excess standardization (see also Grayson, 1970; and Suppes and Morningstar, 1972), and threat to individuality and freedom (see also Suppes and Morningstar, 1972). He argued that educators don't know how to use the potential that the computer offers.

In May, Oettinger (1968) presented the myths of educational technology which include: the political myth, the systems analysis myth, the computer applications myth, and the individualization myth. He felt that the most pressing problem is the lack of an empirically validated theory of teaching.

Early in 1968, Kopstein and Seidel noted that CAI was mainly being used for the presentation of data. They also noted that the main obstacle was the answering of questions concerning instructional strategy (see also Hansen, 1970). In June of 1968, Randall and Blaschke said they felt that management changes must lead to technological changes.

In September of 1968, Kanner said he felt that, like other faded promising approaches of the past, CAI will also be trial and error. Rogers (1968) pointed out the inadequate preparation of teachers to use the results of computer assistance (see also Dick, 1969). Other problems he presented included that there are not enough programmers. Zinn (1968b) pointed out that few lesson designers have made use of the capabilities of the computer beyond those which can be accomplished with the printed format.

In October of 1968, Anderson gave limitations for CAI which include: it is a radical departure from the traditional methods; researchers and developers are not even sure of the variables to use, let alone how they interact; socialization; and whether grouping will still be needed for efficient use of facilities. Also in October, Atkinson and Wilson (1968) listed the problems which include that much of the evaluation is either premature or asks the wrong questions (see also Atkinson and Wilson, 1969).

In the fall of 1968, Oettinger and Marks used the educators' conflicts to argue against both sides in the conflict. They noted that the meaning of individualization is fuzzy. There were also problems with implementing individualization. They felt that the reason for the discrepancy between the promises and reality become apparent through a look at the schools and comparing it with a system which is receptive to technological innovation. Their main point was that the schools exhibit institutional rigidity (see also Papert and Solomon, 1972). Silberman and Filep (1968) noted that there is mixed success of the instructional applications that have been made.

In 1969, Atkinson and Wilson presented problems which include lack of curriculum design. Zinn (1969b) said that many of the differences among CAI languages are only superficial. In 1969, Dick presented an overview of the hardware and software problems which included interface with manufacturers. Hansen and Harvey (1969) commented that the reasons the effect of the computer on the professional roles of classroom teachers remains a conceptual issue are that the role of the computer in the school is speculative (see also Feldhusen, 1970) and that CAI encompasses such a wide range of instructional activities that a wide range of predictions would be necessary in order to predict the impact on the teacher. Uttal (1969) said that the work that is actually being done for CAI is being produced by graduate students and technicians.

Molnar (1969) said that in spite of all the impressive research findings, relatively few educational institutions have adopted instructional technology. He went on to say that the new educational systems have not improved the quality (see also Hall, 1970) nor extended

instruction. The reasons he felt that high costs exist include: education strongly believes in local autonomy (see also Grayson, 1970), lack of marketing incentives, and media are used as add-ons. The problems he saw in terms of quality include: the practice of using full time teachers to develop their own materials has reduced the quality, cooperative purchase and useage of technology is severely limited by laws and autonomy. The problems that he saw for implementation include: natural time lag, there are no incentive mechanisms (see also Gordon, 1969; and Anastasio, 1972), adoption is a local prerogative, and innovation is not readily accepted by the teaching areas.

In April of 1969, Fejfar wondered if the aura of the computer was the source of its interest and value. Also in April, Paulus, McManus, and Page (1969) presented the difficultues they encountered. These included: the length of the response that was allowed, and the limitation on the possible number of responses. Feldhusen and Szabo (1969b) were critical of the fact that unpublished literature dominates in the CAI field (see also Johnson, 1971).

In July of 1969, Starks, Feldhusen, and Bell presented their problems of working with university faculty and graduate students in programming CAI materials. They said that the problems spring from the teacher's experience with and conceptions of teaching. The role definition given by the university administration, students, and colleagues also affect the teacher. Other problems include: fear of computers and terminals, scarcity of good demonstration programs (see also Anastasio, 1972), poor knowledge and structuring of subject matter (see also Block, 1970), lack of competence in communications

techniques, and lack of understanding of learning processes and instruction.

In 1970, Block noted that there is a lack of standardization. Bohnert (1970) noted the fact that people with no data processing experience have difficulty in describing the work they want to have done to computer personnel. Papert (1970) described the relationship between technology and education as one which usually means inventing new gadgets to teach the same old stuff.

Margolin and Misch (1970) noted the obstacles to the implementation of the computer in instruction. They felt that teacher acceptance was the key. Kropp (1970) said that many innovations having considerably less potential than CAI were still-born because the innovators failed to take into account their probable affects on the host's organization, power structure, roles, and sociological status. He then said that there are problems with the development of CAI, but that the whole point of education might be missed if curriculum development were to be given over to non-educators. Martin (1970) noted that the nature of learning theory explains only fragments of human behavior so far. He felt that educators derive generalizations as truth from statistical studies which say that something is slightly more true than false. He also noted that people and time are required to produce and use training materials.

Bushnell (1970) presented his quarrel with CAI which is that it encourages passivity through machine directed learning. He also felt that we know too little about the learning process. He defined a docile teaching system as one which performs operations only on the basis of student requests.

Dwyer (1970) said that there are hidden limitations for interactive computing in education. Systems of inadequate complexity can interact on a total effort in a negative, but often hidden manner. Hall (1970) felt there is an inherent lack of theory upon which the materials and use have been based. The problems he presented include: personnel inadequacies, and competition with administration. Feldhusen (1970) reported the reasons that CAI was in difficulty which include: excessive theoretical speculation, unrealistic speculations, poor quality of current programs, and a tendency to become overly concerned with computer hardware and systems. Hansen (1970) presented a conceptual framework by which to consider the significant research problems within CAI which include those of a psychological nature and learner strategies.

The 1970 Hess and Tenezakis presentation has some implications that are negative. These include loss of status by some information sources, and changes in teacher role. Hunka (1970) found that almost all teachers felt that they would need extra time to make efficient use of the terminal with their students.

Knezovich and Eye (1970) noted that software was the most difficult dimension of educational technology. They felt that someone other than the regular classroom teacher would have to generate CAI materials.

Mesthene (1970) felt that the funding policies and research and development strategies must change if significant technological change is to occur in education. The pitfalls he warned against were: force-feeding, premature exploitation, the seductiveness of rigor, and reinforcement of the values of efficiency and improvement.

Thomsen (1970) noted that the computer will be reaching new groups, and that the effects will be felt outside of the existing formal structures of education. In Readings in Computer Based Guidance, (1970), it was felt that "if man could avoid becoming the tool of his tools, then maybe together, we can do a hundred things we never dreamed of" (p. 23).

In the winter of 1970, Dwyer and Critchfield noted that the number of educators who have had the opportunity for nonvicarious experience with actual CAI systems is uncomfortably small (see also Anastasio, 1972).

Siklossy (1970) presented shortcomings of tutorial programs and structure. He noted the limited answers that are possible with selective teaching using the computer as well as the rigidity and the lack of knowledge that they reveal.

Computer Assisted Guidance: A General Discussion and Case Study (1971) reported disadvantages for CAI which included: there are few off-the-shelf programs (see also Hansen and Johnson, 1971), programs are not appropriate for all subjects, and instructional development requires a team effort. The inherent disadvantages include the time required for using the computer.

Hansen and Johnson (1971) presented some CAI myths which include: the teacher is a total instructional system, CAI computers have been designed for instructional, and there is one best language for CAI. Also in 1971, Johnson noted that instruction through a terminal has a limited content area, and that no interchange of information or programs is intended. Molnar (1971) noted that the computer does not conveniently fit the current educational structure (see also Yeo, 1972).

Technical Augmentation of Human Cognition: An Interdisciplinary

Review (1971) presented the following shortcomings in CAI research. There is a need for: a better conceptual understanding of the learning process, clear-cut criteria for evaluation, leadership, study of the impact of society on CAI, a better interface, more core memory, long range total systems planning, cooperation among research groups, better utilization of CAI, communication of the potential of TAC, and more inter-disciplinary emphasis. The authors went on to say that the greatest barrier is the heavy emphasis on engineering. The next barrier is the self interest of the entrepreneurs.

Early in 1971, Becker presented the following problems that the computer has. There are no simple author languages (see also Anastasio, 1972; and Baker, 1975), there is a lack of theory and experience, there is a lack of research and development money, lead time is needed for projects, and financing and staff are inadequate.

In April of 1971, Seltzer noted that the use of the computer seems to result in a reduced level of positive skill development. Late in 1971, Smith reported that the use of the computer in teaching calculus generated more interest in the computer than in the calculus.

In 1972, Grubb noted that CAI lacks a comprehensive notational system for describing and comparing instructional programs and promoting new design. Papert and Solomon (1972) reported the following images of the computer in education: The computer will program the kid, the kid will program the computer, the conversation that they have will be in letters and numbers, and that the only use of the computer in education is for performing calculations. Young (1972) noted that there is disagreement about the usefulness of the computer in the instructional process.

In the spring of 1972, Anastasio said the manifestations of the factors inhibiting the use of computers in instruction include: there is low motivation, and there is a poor distribution of computer use. The categories of inhibitions were: production/distribution, demonstration, theory of instruction, educational system and teacher, and technical research and development.

In June of 1972, Hammond said that primary education is probably the most important challenge to CAI because of the importance accorded to the teacher-pupil interaction in the primary schools. Hence the computer is usually considered an addition to the normal education process rather than as a replacement for the teacher. He also noted the "wait and see" attitude which is prevalent in education concerning CAI.

In August of 1972, Nyquist said education's financial dilemma is that the school has not learned yet how to provide education for those who are in greatest need of it. Also in August, Starks, Horn, and Slavens reported that there is no significant difference between CAI and traditional education. In the summer of 1972, Yeo included the following problem for CAI: programming is complex to do. In September of 1972, Allen listed factors that were inhibiting all of CAI which included the vicious circle in which demonstrations require money while the money requires a convincing demonstration.

In 1973, Bise concluded that organizational needs are not yet synchronized with human needs and the pace of technology will only widen the gap. In March of 1973, Forcier and Grant discussed six barriers to effective utilization of instructional media which include: lack of clearly defined objectives, unavailability of comprehensive

consultation, difficulty in media selection, and bureaucratic complications.

In February of 1974, McMullen concluded that the attempt to demand precision from those who use the terminal compares with attempts to demand a definition of powers which wise men have left ambiguous.

Baker (1975) noted the negative attitudes which include: fear of change, ignorance of potentials, fear of losing affection, fear of replacement, fear of students who know more than the teacher, curricula that deter innovation, and lack of possibilities for use.

Solutions

Here are presented the proposed solutions for the problems and techniques for implementing the values that the computer can contribute to the educational process. The main presentations are the techniques by which the computer can interact with the student. However, methods of individualizing and methods of gaining acceptance are also frequently mentioned.

In 1961, Carter proposed that experts need to write the materials for CAI; the materials will also need several trials and revisions.

In 1963, Roe described an adaptive decision structure which requires: a data gathering and handling function, a criterion function, decision rules, and a utility function. He went on to say that an adaptive decision structure is dedicated to making decisions in the face of uncertainty or incomplete information. The approaches he discussed include: learning theory (see also Atkinson and Hansen, 1966; and Di Lorenze, 1968), systems, and data handling. The levels of

adaptive behavior he used were: level zero—fixed strategy of presentation, level one—uses student history as part of the presentation strategy, level two—adds performance histories, and level three—adds variation among sets of strategies.

In July of 1966, Oettinger noted that if the vision of technology in education is to come true, it will be through evolutionary change (see also Stolurow, 1968; Hansen and Harvey, 1969; and Molnar, 1969). In the fall of 1966, Atkinson and Hansen presented the major purpose of research as providing the basis for development of a theory that will describe the conditions under which an instructional procedure optimizes learning. In December of 1966, Hansen noted that the primary evaluations of CAI languages concern efficient computer usage. The applications of CAI that he described include: drill and practice (see also Chorvinsky, 1967; Zinn, 1967b; Zinn, 1967c; Goodman and Gould, 1968; Maloney, 1968; Hickey, 1968b; Suppes, 1968; Atkinson and Wilson, 1968; Stolurow, 1969b; Paulus, McManus, and Page, 1969; Block, 1970; Hall, 1970; Knezovich and Eye, 1970; Margolin and Misch, 1970; Parkus, 1970; Selzer, 1971; Woodson, 1973; and Hedges, 1973), testing (see also Bushnell and Allen, 1967; Chrovinsky, 1967; Zinn, 1967c; Hickey, 1968b; Maloney, 1968; Hickey, 1968c; Hedges, 1973; and Tennyson, 1974), and tutoring (see also Chorvinsky, 1967; Zinn, 1967c; Goodman and Gould, 1968; Maloney, 1968; Suppes, 1968; Hickey, 1968a; Atkinson and Wilson, 1968; Stolurow, 1969b; Bell and Moon, 1969; Blum and Bork, 1969; Paulus, McManus and Page, 1969; Hansen and Lippert, 1969; Block, 1970; Coulson, 1970; Hansen, 1970; Knezovich and Eye, 1970; Parkus, 1970; Selzer, 1971; Oldehoeft and Conte, 1971; and The Fourth Revolution: Instructional Technology in Higher Education, 1972).

The computer research for instruction that he noted includes: quantitative instructional models, computer simulation models (see also Blum and Bork, 1969), and psychological experimentation.

In 1967, Bushnell and Allen proposed the following areas of computer applications in education: environmental control, evaluation (see also Heimer, 1969; and Hansen, 1970), curriculum planning (see also Dick, 1969; and Hansen and Harvey, 1969), gathering and retrieving data about cumulative experience, and student-subject matter interface. Richards (1967) said that the main need for concern is role psychology.

Also in 1967, Chorvinsky presented the applications that he saw for CAI which included simulation (see also Zinn, 1967c; Goodman and Gould, 1968; Bitzer, 1968; Hickey, 1968c; Maloney, 1968; Hickey, 1968b; Zinn, 1968a; Atkinson and Wilson, 1968; Zinn, 1969a; Bryan, 1969, Bork, 1969; Bitzer and Skaperdas, 1970; Block, 1970; Hall, 1970; Hansen, 1970; Knezovich and Eye, 1970; Margolin and Misch, 1970; Parkus, 1970; Seltzer, 1971; The Fourth Revolution: Instructional Technology in Higher Education, 1972; Rudolph, 1972; Woodson, 1973; Tennyson, 1974; and Baker, 1975). Wodtke, Brown, Sands, and Fredericks (1967) reported that the effects of scrambling the frames of instruction were not as great as had been expected.

Zinn (1967c) reported that the modes of CAI included: problem solving (see also Zinn, 1967b; Goodman and Gould, 1968; Maloney, 1968; Hickey, 1968a; Stolurow, 1969b; Coulson, 1970; Hansen, 1970; Knezovich and Eye, 1970; Parkus, 1970; Seltzer, 1971; Oldehoeft and Conte, 1971; The Fourth Revolution: Instructional Technology in Higher Education, 1972; Rudolph, 1972; Hedges, 1973; and Baker, 1975), gaming (see also

Zinn, 1967b; Goodman and Gould, 1968; Hickey, 1968c; Hickey, 1968b; Zinn, 1968a; Atkinson and Wilson, 1968; Zinn, 1969a; Bryan, 1969; Feldhusen and Szabo, 1969b; Block, 1970; Knezovich and Eye, 1970; Margolin and Misch, 1970; Parkus, 1970; Seltzer, 1971; The Fourth Revolution: Instructional Technology in Higher Education, 1972; Rudolph, 1972; Woodson, 1973; and Hedges, 1973), information retrieval (see also Woodson, 1973, and Tennyson, 1974) and computer aided design or composition (see also Zinn, 1967b; and Papert and Solomon, 1972). The levels of design strategy that he presented were: patterns to facilitate learning, and procedures by which to derive the best patterns. The strategies he presented for learning include: basic track strategies, molar decision strategies, molecular decision strategies (see also Zinn, 1967b), and definition or determination of an element in an instructional pattern.

Filep (1967) felt that the impersonal aspect is of value since: it can reduce the tension that a student feels concerning the material and the interaction with the teacher, and it can be used to reach those who are alienated by the interaction with the traditional schools.

Zinn (1967b) structured his review of computer technology for teaching and research in instruction to include: modes of student assistance, computer aids for instructional management (see also Goodman and Gould, 1968; Zinn, 1968a; and Zinn, 1970b), computer based tools (see also Zinn, 1968a; Atkinson and Wilson, 1968; Blum and Bork, 1969; Hedges, 1973; and Vinsonhaler and Moon, 1973), and trends. The modes of instruction he presented include: author controlled tutorial (see also Zinn, 1968a; Zinn, 1968b; and Zinn, 1969a), dialogue tutorial (see also Feldhusen and Szabo, 1969a), and retrieval and reorganization

of information (see also Hickey, 1968b; Coulson, 1970; and Knezovich and Eye, 1970). In his discussion on strategies he started with the learning situations and conditions (see also Hickey, 1968b), then went through response processing and feedback (see also Hickey, 1968b; Block, 1970; and Lyons, 1970), sequencing and selection rules (Hickey, 1968b; Hansen, Dick, and Lippert, 1969; Block, 1970; and Lyons, 1970), generation or assembly procedures, and self modifying strategies.

Bitzer (1968) presented the guidelines that were used in the development of the PLATO system. These include: use the computer when it is the best method of presentation (see also Kurland, 1968; Bitzer and Boudreaux, 1969; Bitzer and Skaperdas, 1970; and The Fourth Revolution: Instructional Technology in Higher Education, 1972), the system must be flexible and adaptable (see also Bitzer and Boudreaux, 1969; and Bitzer and Skaperdas, 1970), give consideration to the integration into the educational system (see also Kurland, 1968; and Bitzer and Skaperdas, 1970), and make it for the same cost as conventional education (see also Kurland, 1968; Dick, 1969; Bitzer and Skaperdas, 1970; Dwyer, 1970; Seltzer, 1971; Nyquist, 1972; and Tennyson, 1974). Crawford (1968) tried to explain why CAI is so slow about coming into being and says that media are now coming together in an organic manner (see also Uttal, 1969) rather than as a collection. The new conditions mean that each person must have the capacity to acquire the knowledge that he needs for any situation. Hickey (1968c) presented remedies for problems of using CAI which include: form user groups, and try CAI (see also Hedges, 1973). Hickey's instructional strategies for CAI include: linear (see also Hickey, 1968b; and Blum and Bork, 1969), branching, adaptive (see also Hickey, 1968b; and Blum and Bork, 1969),

Socratic (see also Hickey, 1968b; Blum and Bork, 1969; and Margolin and Misch, 1970), and learner controlled (see also Hickey, 1968b). Kurland (1968) felt that a large (see also Oettinger and Marks, 1968; Molnar, 1971; and Ellson, 1972), carefully coordinated (see also Technological Augmentation of Human Cognition: An Interdisciplinary Review, 1972) research and development effort must be undertaken both to discover how to use the computer effectively to improve education (see also Feldhusen, 1970; Mitzel, 1970; Grayson, 1970; Seltzer, 1971; and Ellson, 1971) and to produce evidence of the relative value of the new technology in comparison with alternative approaches (see also Mitzel, 1970). The major development objective should be increasing compatibility of computors and their materials (see also Feldhusen, 1970). Maloney (1968) said that computers can be applied to education in administration (see also Grayson and Robbins, 1972; and Young, 1973), research (see also Zinn, 1969b; Dwyer, 1970; Zinn and McClintock, 1970b; and The Fourth Revolution: Instructional Technology in Higher Education, 1972), CAI (see also Becker, 1971; Rudolph, 1972; Young, 1972; Tennyson, 1974; and Baker, 1975), CMI (see also Randall and Blaschke, 1968; Becker, 1971; Rudolph, 1972; Vinsonhaler and Moon, 1973; Tennyson, 1974, and Baker, 1975), and CBI. He felt that the teacher's role in the classroom will change (see also Chapman, 1970). Pfeiffer (1968) pointed out that the educator wants the computer to be an aid (see also Bunderson, 1970a; and Bunderson, 1970b) while industry seems to want it to be a total educational system (see also Bunderson, 1970a, and Di Lorenze, 1968). Di Lorenze (1968) said that educational specifications for CAI are as follows. In the software area: subject (see also Jerman, 1969), course, individual differences,

flexibility (see also Obertino, 1974), test materials, and evaluation. For the students' terminals: rate of learning, and objectives. For the staff: administrator role (see also Zinn, 1968c; and Blum and Bork 1969), and teacher role. He suggests a network approach (see also Hickey, 1968c; Hickey, 1968b; Zinn, 1968b; and Grayson and Robbins, 1972) for New York.

In 1968, Hickey's (1968b) survey included the following applications of CAI: intellectual skills, task skills, and vocational guidance and counseling (see also Hansen, Dick, and Lippert, 1969; Grayson and Robbins, 1972; Tennyson, 1974; and Baker, 1975). The major centers for CAI were categorized as follows: university centers (see also Hansen, Dick, and Lippert, 1969), industrial centers, military centers, public school districts and consortia, individual public and private schools, and time sharing networks. He categorizes programming languages as problem and calculating languages, text processing languages, compilers (see also Frye, 1968) assemblers, and utility programs. His report of instructional strategies included the category intrinsic (see also Blum and Bork, 1969), as well as many mentioned above. The categories of stimulus and response factors that he used were sequence variables, stimulus characteristics, response mode, feedback, and response management.

A 1968 undated report by Rodgers and Gariglio noted that the congeniality of the computer is usually related to how quickly and easily the user can get to the system. They also felt that the CAI mode of use of the computer is teacher directed.

Also in 1968 Silvern discussed the roles of CAI according to the categories: learner (see also Zinn, 1969a), teacher (see also Zinn,

1969a; Stolurow, 1969b; and Grayson and Robbins, 1972), instructional programmer, computer programmer, and computer operator.

Stolurow (1968) said that the system development process for CAI needs to be cumulative and that it needs to be planned as a program of innovation by the computing industry. Zinn (1968c) presented the following kinds of users of interactive systems for instruction: instructors (see also Zinn, 1969b), authors (see also Zinn, 1969b; Stolurow, 1969b; and Knezovich and Eye, 1970), and programmers and analysts (see also Zinn, 1969b).

Early in 1968, Silberman said that the four areas of computer applications in education include: the computer as a subject (see also Block, 1970; McDonald, 1970; and Grayson and Robbins, 1972), the computer as a tool of instruction (see also Coulson, 1970; McDonald, 1970; The Fourth Revolution: Instructional Technology in Higher Education, 1972; and Grayson and Robbins, 1972), the computer as a tool in research and development, and the computer as a management tool.

In April of 1968, Atkinson used levels of CAI which included: systems that present fixed programs (see also Hall, 1970) which is the simplest interactional level, and systems that are student system interaction or dialogue systems (see also Suppes, 1968) at the other extreme. Also in April, Suppes' (1968) categories included dialogue (see also Block, 1970; Knezovich and Eye, 1970; Parkus, 1970; and Seltzer, 1971). He argues that impersonalization is not necessary with CAI, that routine matters can be taken over by the computer, that the computer can give individual attention, that standardization is not necessary, and that unlimited diversity is possible.

In September of 1968, Frye surveyed and classified languages using categories which included: adapted conventional (see also Zinn, 1969b), interactive (see also Zinn, 1969b), and instructional. Zinn (1968b) noted that the applications for students appear to vary along a dimension of author to program control. He felt that materials developed on a cooperative basis (see also Feldhusen, 1970; Lekan, 1970; Molnar, 1971; and Rudolph, 1972) would be more usable at the different institutions than if they were developed independently.

Hickey (1968a) reported on time sharing uses which include: on-line (see also Block, 1970; and Bunderson, 1970b), and classroom demonstrations. Atkinson and Wilson (1968) presented the following modes of CAI: response sensitive, and optimization strategies.

In 1969, Bell and Moon said that the ideal may be learning about the computer from the computer. The criteria for decisions related to instructional applications of the computer include: as a medium it can perform tasks that can't be done as effectively in any other manner, can't be duplicated at less cost, and it can provide better motivation; as an object it can teach how the computer functions, the best types of functions for the computer, and how to communicate with the computer; in terms of software, programs may exist which can perform the desired process, teachers can write programs (see also Chapman, 1970), and computer aided programming is possible; and in terms of instructional control a demonstration terminal helps, a small group working situation is needed, and single student working situations (see also Bunderson, 1970b) are needed. The classroom use of CAI, augmented with TV (see also Becker, 1971), was felt to be extremely effective by the authors.

Blum and Bork in 1969 presented the pedagogical facilities that they felt were needed which include: interactive, semi-interactive, and non-interactive. The criteria for the type of facility are turn-around time and debugging requirements. They felt that the computer as producer of material is still little known. They noted that simulations may be of either the black box or Monte Carlo type.

Brown, Lewis, and Harcleroad (1969) presented an interesting counterpoint to the teacher fear that machines will take over the educational process. They said that any teacher that can be replaced by a machine should be (see also Dawson, 1970).

The overview of CAI by Dick (1969) presented a series of propositions he felt to exist: the higher the terminal criteria the more difficult will be the programming and the more complex will be the instructional strategy, CAI is a tool which should fit within any curriculum, and role differentiation (see also Hansen and Harvey, 1969; and Hansen, Dick, and Lippert, 1969) in the development team has a high payoff.

Hansen and Harvey (1969) felt that the impact of CAI on classroom teachers that will be primary for role factors is the allocation of teacher activities, and there will be a greater team approach (see also Feldhusen, 1970; Bunderson, 1970b; and Zinn, 1972). They felt that the pattern of development (see also McDonald, 1970; and Allen, 1972a) is: commitment to individualization, development of IPI, development of CMI, availability of CAI and other multimedia devices, and then a new form of individualization.

Jerman (1969) presented the following criteria for evaluation of a CAI system: population, simplicity, efficiency, and reliability

(see also Feldhusen, 1970). Uttal (1969), presented a continuum of languages which runs from selective (see also Siklossy, 1970; Uttal, Pasich, Rogers, and Hieronymous, 1970) to generative (see also Atkinson and Wilson, 1968; Wexler, 1970; Siklossy, 1970; and Uttal, Pasich, Rogers, and Hieronymous, 1970). He added degenerative languages (see also Uttal, Pasich, Rogers, and Hieronymous, 1970). He felt that the best model for CAI is the human tutor. Zinn's (1969a) modes of computer uses included learning tools (see also Zinn and McClintock, 1970a). The types of users he presented included the curriculum writer.

In 1969, Molnar noted that incentive mechanisms are needed (see also Levien, 1971). Stolurow (1969b), presented the implications of the formalizing process for CAI materials to include: models must be made operational, students' actions at the computer are recorded, and verification of materials is enhanced. The same system can be used for validation and verification. This makes a complex series of events in the student-system interaction replicable with high reliability. He also presented the following test for a theory: internal consistency, ability to account for the data, and utility. Stolurow (1969a) discussed the major modes of CAI and included inquiry (see also Feldhusen and Szabo, 1969b; and Hedges, 1973).

In January of 1969, Gordon noted that the hardware should be available at all times. He also noted that the faculty doesn't have time for creating programs for CAI. Also in January, Roth (1969) said that he felt that forward looking publications are creating software programs that are needed for the CAI individualized instruction courses.

Early in 1969, Bitzer and Boudreaux said that they felt that computer based education should be used to do what it can do for nursing education.

In March of 1969, Bryan discussed computers and education using categories of computer activities which included: ad lib, in which the student leads; and controlled, where the student is led by the program.

In April of 1969, Bork presented the ways that he felt the computer can be used in education and includes: computer produced materials, computer directed teaching, and computers as computers. For Feldhusen and Szabo (1969a), the major types of CAI included didactic instruction.

Also in April of 1969, Hansen, Dick, and Lippert presented computers in education and said that they felt that the university based CAI center provides a broad range of scholarly investigations. The activities that they report include: design of instruction (see also Bunderson, 1970a; and Coulson, 1970), memory, graphics, behavioral indices, man-machine factors, and conversational.

Block in 1970 discussed a range of instructional activities which went from response insensitive to response sensitive. The levels of computer involvement in decision making that she presented included: on-line and off-line. Another distinction goes from basic skills to competence or mastery of a subject. The different modes of CAI that she saw included data base manipulation.

Bunderson (1970a) presented the current issues regarding CAI which included: Is it a new medium or a new technology? Bunderson (1970b) presented his techniques for overcoming the problems of implementation

which began with a research based technology of instructional design. He said that the sources of increased efficiency and effectiveness include dynamic communication. The variables that he felt should be considered in the design of a dynamic interface include: active response, immediate feedback, appropriate media and method, and motivation. He said that CAI will never succeed if it does not have at least the status of a term paper. He felt a service oriented system with clusters of terminals located conveniently is necessary.

Chapman (1970) said that the skills needed for a teacher to use CAI are: ability to program instructional materials, mastery of the subject, and a new educational environment. The opinions that he felt exist about CAI are: that CAI is a tool that is controlled by the teacher and that the computer should occupy a separate domain from the teacher. He concluded that it is unreasonable to expect a uniform job description for teachers in CAI. The required skills were more closely related to educational technology and individualized instruction than to computer technology.

Coulson (1970) named the following applications for instructional assistance: automated library, classroom information system for instructors, and data management aid.

Dwyer in 1970 grouped support systems by: technological support, pedagogical and logistic support, and administrative support. In the technological he included system and language level software, and research and development. In pedagogical and logistical he included curriculum material, scheduling, and critical size. In the administrative he included teacher training, public relations, and economics. He felt that communication (see also Feldhusen, 1970; Hess and Tenezakis,

1970; and Lekan, 1970) may well be the most important large system component that should be added to the checklist of every project.

In 1970, Feldhusen included the following recommendations for CAI development in his paper: there is a need to standardize and simplify a programming language for CAI; there should be much communication among systems designers, programmers, school administrators, teachers, and students in the design of CAI systems; and there is a need to develop more CAI programs which teach well (see also Hess and Tenezakis, 1970).

Hall (1970) presented types of CAI which include: laboratory computing device, and record keeping. Hansen (1970) said that he felt that the applications for CAI, in essence, represent a match between the computer as a tool and a specific educational problem.

Hess and Tenezakis (1970) presented the computer as a socializing agent. They noted that attitude systems, like scientific theory, have high thresholds to change. The sophistication with which instructional materials are organized and presented is contingent upon the versatility of the machine. The dimensions of communicator effectiveness that they present are: credibility, attractiveness, and power.

Hunka (1970) described the methods used to achieve acceptance of computer terminals. The parents were brought in after their children had a chance to learn to use the terminal. The students of higher grades wrote functions for drill work which were used by students in lower grades. The teachers who were most actively involved reported that there was better interest and motivation on the part of the students using the computer.

Charp (1970a) discussed how to make computer technology in education viable. She noted the use of the computer to analyze unexpected responses of students. She felt that people are needed who will bridge the gap between data processing and education. Vollenbergh (1970) felt that automation can only develop via an open ended strategy in which many are participating (see also Dwyer and Critchfield, 1970). Zinn and McClintock (1970) felt that current trends were away from sequential programming and were moving toward generalized curriculum procedures. The information categories they reported were being used were: operations, curriculum development, languages and instructional strategies, evaluation, and dissemination. The applications of the recommendations were: management, instruction, and exploration.

Knezovich and Eye (1970) presented the instructional modes of the computer which included testing and scoring. They felt that teacher assisted computers are needed in order to get the maximum potential from the new instructional technology. Lekan (1970) felt that sharing information and results of development is necessary.

In 1970 Lyons said that he felt that the main variables for human resources research were differences in entry characteristics and mode of learning. The mode variables that he considered included: use of visuals, availability of supplementary material, use of printed text, and more. The factors that he felt instructors should continually consider were: entry characteristics, educational level and background, trainee's responses, latency, response history and patterns, prestored norms, and characteristics of the subject matter. He concluded that the computer is valuable as an instructional tool only to the extent that it is properly imbedded in an effective total instructional system.

The most critical elements of an effective instructional system, he felt, are a well-defined set of appropriate training strategies to reach those objectives.

Bright (1970) noted that teacher acceptance is the key to acceptance of the computer in the classroom. Duhl (1970) noted that meaningful teaching needs a base of theories of cognitive development and learning. He went on to conjecture that perhaps all education should be a continuous "Hawthorne experience." Kropp (1970) felt that the whole point of education might be missed if curriculum development were given over to non-educators (see also Allen, 1972a; and Allen, 1972b). Margolin and Misch (1970) presented the following teaching models in rough order to increasing complexity: drill and practice, concept introducing tutorial schemes, and Socratic strategies, as well as programming by students (see also McDonald, 1970). The categories under which they analyzed the effect of various financing methods are motivation, investment of risk, and management of research. McDonald (1970) noted that success of projects is attributed to cooperation of educational jurisdictional levels which in the past have remained nearly autonomous. She also noted that the effect of teaching patterns on implementation is unvalidated. Thomsen (1970) said that the best question at present is: Who can now afford CAI? He noted that small pieces of the learning institution will be scattered. He felt that teaching strategies need to be sympathetic with learning motivations.

Mitzel (1970) discussed how to evaluate CAI. The classes of evaluation activities that he used are formative (see also Teates and others, 1970) and summative. The queries that he proposed for

evaluating CAI include: How can the proper weights be given to cognitive and affective criteria? Are obtrusive and unobtrusive (such as attention span, time to gain mastery, absentee rate, teacher reprimand) measures equally persuasive to decision makers?

The 1970 Readings in Computer Based Guidance presented a series of proposals which included: communicative relationships between human beings and extra-human entities do exist, this synthetic relationship can be therapeutic, there are dimensions of personality the presence of which may be significant to one's probability and/or capability for relating with the computer. They concluded that "if man can avoid becoming the tool of his tools, then maybe together, we can do a hundred things which we have never dreamed of" (page 23).

Sekowski (1970) used roles that included: user, translator, and developer. The hypotheses of interest here are: users relate needs more effectively to a translator, the translator interpretation of the problem to the developer is more efficient than other ways, and the success and maintenance of a system is directly related to the amount of feedback received.

Teates and others (1970) said that the use of CAI was proposed as potentially the most appropriate and efficient means of monitoring progress in order to create supplementary materials for ISCS. They felt that for the most efficient use by the revision teams, the data generated by the CAI programs need to be summarized. They also noted that the first year's materials contained gaps and errors too large to be detected and corrected readily by the CAI evaluation techniques.

Zinn and McClintock (1970a) discussed CAI information organizations under the following categories: student levels, subject areas, learning

strategies, hardware, programming languages, computer functions, and user purposes. These are possible categories for the paradigm.

In the winter of 1970 Dwyer and Critchfield presented the results of a "no-holds-barred" practicum aimed at developing computer usage for scholarly exploration of the high school curriculum. Most of the teachers showed a natural gravitation toward various nontutorial modules in their development of materials. They also found that grouping by subject matter was irrelevant. They found as well that the attitudes of the teachers toward the computer changed as a result of the practicum.

In March of 1970 Grayson said that he felt that the likelihood of undesirable impacts of CAI need to be lessened (see also Abelson, 1972). In August of 1970 Zinn (1970b) used categories which included the following in a review of the literature: instruction and the learning process, and preparation and display of materials. In November of 1970 Porter noted that through a well thought-out program of computer assignments the student can be led to formulate definitions for himself. In December of 1970 Wexler used the following modes of operation of CAI: the teacher mode, in which materials are formed; the student mode, in which materials are used; and the dialogue mode, in which additional information is acquired. Siklossy (1970) noted that a truly generative CAI has to develop the answers itself.

In 1971 Bond gave the following classifications of motivators for technical students: task related or intrinsic, need related or dynamic, and external. Computer Assisted Instruction: A General Discussion and Case Study (1971) for the elements that were felt to be needed for a CAI project, used: resources for a long term project, stable subject

matter, many people to be trained, a subject matter that is suited to CAI, and potential full use of the computer. The elements that were needed for a course included: authors with time to develop materials, experience in the subject area, acceptance of educational technology, a validated course, behavioral objectives for the course, and several authors. Also in 1971 Hansen and Johnson said they felt that an information management system is needed which includes: information retrieval, training requirements, and use of computer support of instruction.

In 1971 Levien said that if we are to achieve innovation in education, we shall have to consciously design our institutions to encourage and facilitate it. The phases of educational innovation that he presented are development, and introduction into practice. The trends that he said are making a computer market possible include: commercial time sharing service, and cheap and standardized mini-computers (see also Becker, 1971) with some exchangeable medium available.

Molnar in 1971 said that the agents that he felt could provide the necessary catalyst for innovation include business creating a market mechanism, and the federal government providing leadership. Seidel in 1971 said he felt that a nonprofit special organization is best as a developer of CAI materials. He argued that universities are not product-oriented and have other priorities and therefore no incentives while publishers want to make a profit and see the research as too expensive for the potential profit to pay for. Because of the non-profit organization's mission orientation, internal organization, and reward structure, he felt that it would serve this end best.

In October of 1971 Oldehoeft and Conte reported modes of instruction which included the investigation mode which entails showing solution ability without automatic checks on proper formulae and parameters.

Smith (1971) concluded that some of the problems used in CAI should be required for students, that more preparation is required than for conventional instruction, and that more terminals were needed in the classroom than he used.

In 1972 Ellson said he feels that financial assistance is needed. In The Fourth Revolution: Instructional Technology in Higher Education (1972) the tests for using technology included: Is the task to be learned essential? The categories of instructional computer use they gave include: data processing (see also Grayson and Robbins, 1972), computer science (see also Baker, 1975), and demonstrations. Also in 1972 Grayson and Robbins listed instructional uses of the computer which included curriculum development.

Rudolph in 1972 presented classifications for instructional use which include: electronic data processing (EDP), and computer mediated instruction. Her recommendations for educational change included: add an effort to expand instructional use to new areas, and create a central facility providing impetus for software interchange.

Also in 1972, Young found that local access results in increased perceived degree of usefulness for administrative and vocational areas and decreased degree of usefulness perceived for CAI. Also he found that local access results in less uncertainty of attitudes. He found that principals with access see the computer as being less useful for CAI than teachers who have access. He concluded that research is needed to determine the relationships between knowledge and attitudes.

In January of 1972, Dwyer discussed materials that were authored by both teachers and students. He distinguished between dual and solo modes of computer interaction. With the solo mode the pedagogically-intended master program is absent from the interaction. The requirements that he felt were needed for a system within which such an educational approach will work include: easy access to the system in all modes, the full power of the general purpose computing ability should be available at all times to all users, and the system should be "approachable" on the educator's terms.

In March of 1972, Allen (1972b) said he felt that the programs for individualization had to be user-oriented, that the student should be encouraged to guess, and that it is easier to learn to program a computer than it is to learn to teach a language. In April of 1972, Papert and Solomon presented things to do with a computer. In it they gave examples of things that can be done with the Turtle terminal device. The things include: make a Turtle, use a Turtle, play Space War, work with differential geometry, make a music box, program a tune, compose music, control a crane, make a light show, compose poetry, do physics experiments, and operate puppets.

In July of 1972, Abelson advocated an effort in exploiting the new technology. Also in July Zinn discussed the factors that he felt were of interest for CAI research and development which include: balance of control, extent of diagnosis, prescription, variety of information processing activities, type of interaction, role of the computer, and the "naturalness" of communication. The major trend in design is toward control by the learner. He felt that information dissemination was needed. He felt that complementary roles for the

subject matter and the computer science experts are needed. In summary, he felt that computer literacy was needed.

In September of 1972, Allen (1972a) discussed the pattern that he saw emerging in the developments which has the following features: it will avoid the rigidity of the past, and there will be a growth of computer supplemented instruction (see also Vinsonhaler and Moon, 1973).

In 1973, Bise said he felt that the next shift in technology will not have a stable pattern of human behavior.

In March of 1973, Forcier and Grant said they felt that the instructor needs to have a consultant available to assist him in using the media resources that are available. Also in March, Woodson (1973) presented programming heuristics which include: frame-by-frame, problem generators, and diagnostic and testing.

In November of 1973, Hedges suggested that the educator who wishes to explore CAI should: take a programming course designed for educators, begin reading the more technical journals, and recognize the educational technologist. Practical first steps that he said were feasible in many schools at this time include: persuade the school board to rent a single computer terminal for one year, with a faculty member supervising its usage; have a faculty member spend a summer taking computer type coursework; and ask a community member for technical assistance.

Vinsonhaler and Moon (1973) presented categories of instructional applications which include CAT (Computer Administered Testing), and CAdI (Computer Administered Instruction). The instructional activities that they reported are: preparation, sequencing, presentation, and

evaluation. They noted that finding a suitable language no longer appears to present a major obstacle to the development of good instructional systems. They felt that CAI for the future needs personnel who are capable of relating the existing technical tools to the very human process that is education.

In 1974 Obertino noted that a computer based curriculum must allow teachers to shape it to their classroom practices before it will gain acceptance. The behavior of children and the comments of teachers are the chief sources of information as to what kinds of materials will have maximum utility and appeal. It was found that the interactive display could not in itself maintain interest. In May of 1974 Tennyson separated instructional support into direct and indirect categories.

CHAPTER III

THE PARADIGM AND THE INTERVIEW SCHEDULE

This chapter begins with a summary of the literature that uses the categories of the paradigm. The remainder of the chapter is a presentation of the interview schedule which has two major components: the teacher schedule and the administration schedule.

Literature Summary

An analysis of the literature reveals that the paradigm categories (see Figure 1, page 3) of Interaction Style, Ways the Computer is Used, and Attitude were emphasized in the positive values. The problems or negative aspects emphasized the categories: Attitude, Administration, Amount Available on the Computer, and Programs Available. The solutions emphasized the categories: Number of Computer Applications, Interaction Style, Ways the Computer is Used, Interaction with Computer, Amount Available on the Computer, and Programs Available.

The solutions covered most of the items in the paradigm while the negative aspects left the most gaps and emphasized the least. The categories with the least emphasis for all literature included: Amount, Time Used, Student Individually, Time Language Known, Number of Programs Written, Classroom Use Amount, Operating Policies, Scheduling, Speed, Known, and Other Hardware.

Amount

The Amount of Time Used in the Creation of Materials was referred to negatively in terms of requiring the teacher to develop his own materials. However, this was also given as a solution by some authors. They also discussed curriculum planning, using the computer for refinement rather than for creating materials, and using teacher comments and children's behavior as resources for improving materials. The Amount of Time Used by the Teacher in the Classroom is hinted at by TV aided CAI, and by the feeling that more preparation is needed in order to use CAI. The Amount of Time Used by the Student Individually is implied by the solution that CAI should be used by a single student at a time. That Time is Used is implied by the problem that there is a natural time lag and the solution that allocation of teacher activities is needed.

The Number of Courses is implied by the references in the literature to subjects and courses. The Number of Students is indicated as a category by the positive value of mass education as well as the solutions concerning use of a small group and the need to have many to be trained. The Time Used and the numerations fit within an overall category of amount of computer use which in the paradigm is called Amount.

Teacher

The Teacher category in the paradigm is supported by the idea of teacher assisted computers and by the fact that teachers shape CAI to fit their classroom practices. The category of Support within the

Teacher category has the positive values of teacher summary of data and teacher adaptation assistance as well as the solution possibility of better motivation.

Within the Support of the Teacher category is the subcategory Number of Computer Applications. This is heavily represented in both positive values and solutions with no representation from negative aspects and the heaviest representation in solutions. The positive values are information processing aid, unlimited diversity as an aid for education, unique contributions for which no feasible alternative exists, and the identification of special needs of students. The possible solutions include: the computer as an aid in design and composition, the subject of computer science, and relating existing tools to education. One author spoke of direct support which provides teaching activities and indirect support in which administrative and information processing activities are included.

Another category within the Teacher Support category that has heavy emphasis is Interaction Style, Here there are some negative aspects presented while positive values and solutions are about evenly represented. Positive values of the Interaction Style deal mainly with the sophisticated reinforcement contingencies that become possible through the use of the computer. These are techniques to individualize for differences among students which include variation dependent on the response of the student, on the history of the student, and on the response history of the student. These adaptations could vary the pace, content, scope, presentation style, mode of presentation, sequence, and difficulty level. The computer can give patient attention to the student or be a timed mechanical teaching

device. These possibilities add to the multisensory adaptation with multimedia presentation that can exist with CAI.

The computer could interact also in student production or as a helpmate to facilitate learning in which the student could control the direction of the proceedings. Some authors feel that the computer can provide a humanism due to its lack of discrimination. Thus it could encourage open-mindedness and develop appreciation of the computer as an information source.

The problems presented with respect to Interaction Style begin with the fact that most teachers seem to teach as they were taught rather than as they were told was right. In addition, use of the computer requires preparation and many feel that the only reasonable use of computers is for calculating. The individualization of instruction also has many problems due to the fact that what individualizing means is not yet clearly defined by educators.

The solutions given for Interaction Style emphasize the variations that are possible in diagnosing student needs and in the presentation of the materials. The balance of control, modes of computer assistance, and information organization are discussed. Adaptation would use such things as the characteristics of the subject matter, the performance of students, and the history of students. Human factor components are also presented under solutions and include the processing of natural language and the naturalness of the communication. An adaptive decision structure is presented for use in developing and maintaining materials.

Another category within the Teacher Support category is New Ideas. There is a small amount of support for this category. Again the emphasis is in solutions. The positive values are that the student could

learn how he learns, that teaching could be less machine-like, that the teacher could gain a perspective of the subject, and that the author could discover an organization of his material. The negative factors were essentially that the high school student does not have an appropriate background for learning computer science. The solutions include the possibilities of such things as control of the student's educational environment, the use of behavioral indices to apply the appropriate media and method, a new educational environment, and the computer serving as a socializing agent.

The last subcategory of Teacher Support is Ways the Computer is Used. This category has almost as much emphasis in the literature as the Interaction Style category. The positive values for the Ways the Computer is Used include: improvement over traditional education in terms of both teaching more and making more effective use of time, scientific education, and top-flight instruction. The main emphasis in the solutions is things that are different from the traditional classroom such as clinical teaching, library resource, text manipulation and drawing, instructional stability, and synthetic confrontation therapy. The computer provides enrichment in many ways and can provide guidance. The computer can be used for problem solving, gaining insight, providing safety and expediency through the use of models and simulations, and extending and complementing natural learning skills.

The problems in the Ways the Computer is Used include: the lack of adequate theories and valid experience, it is a docile teaching system, and it encourages passivity. The solutions presented in the literature emphasize such things as CAI, CBI, CMI, CEI, CSI, CAT, and computer administered instruction, as well as the computer as subject

or as tool for instruction, in research, and in management. The solutions also include uses in support of the teacher such as data gathering and handling, aid in instructional management, vocational and clinical guidance and counseling aid, and tool for dissemination of information. The research uses include psychological experimentation, instructional development, and laboratory computing. The student uses include problem solving, tool for learning, simulations of both black box and Monte Carlo types, and information retrieval. There are also presented techniques for use, unique contributions of the computer, and technical aspects of computer use.

The Instruction Types subcategory within the category Ways the Computer is Used in Teacher Support also emphasizes solutions with only one negative aspect. The positive aspects for Instruction Types include automatic grading and teaching, assistance with instructional management, improving skills, providing access to library resources, and analysis of specifics. The problem is that positive skill development was reduced. The solutions include drill and practice, tutoring, simulations, gaming, and inquiry types of instruction for learning intellectual and/or task skills. Tutorial types can be linear, branching, adaptive, Socratic, didactic, ad lib, teacher-controlled, or student-controlled.

The Logic Complexity subcategory of Ways the Computer is Used has more negative aspects and less of both positive aspects and solutions than Instruction Types has. The positive implications of Logic Complexity include complex internal branching and complex instructional strategies. Contributing to these complexities are the rich evaluation criteria and selection functions as well as versatility of response

accomodation and intricacies of the material. The negative aspects include the fact that inadequate complexity of CAI materials has been made available since the internal complexity of the computer has not been externalized. This points out the complexity of the programming necessary and the limitations of selective teaching CAI programs. The solutions indicate a trend away from sequential programming with its sequencing and selection rules to generation and assembly procedures, response processing and feedback, and self-modifying strategies. Response sensitive strategies could use rate of learning, intrinsic characteristics of both the subject matter and the student, and baseline performance data for adapting instruction.

The last subcategory of the Ways the Computer is Used for Teacher Support is Language Level. No positive or negative aspects occur for this entry while solutions are poorly represented. Conventional compilers and interactive translators can be used as can adapted conventional or instructional versions. The instructional language continuum has two dimensions which start with selective presentation and degenerative presentation. Both have at the other extreme the generative development of the presentation by the computer.

Another subcategory within the Teacher category is Attitude. This category has considerable negative aspects with few solutions (which supports the current thesis!). The positive aspects deal with the effect on the future, the intuitive value, and the substantial innovation that the computer provides. Thus it is a valuable learning asset that improves performance, reduces instructional time, and improves the availability of education. The interaction with the computer has been found to improve attitudes and decrease apprehension

about the computer. Otherwise the person's environment is the source of the image of the computer. Outside effects of the computer include amplification of man's powers, reaching new groups, and modification of social integration.

The problems presented for the Attitudes category emphasize change. Some feel that change must be evolutionary while others feel that CAI will fade like other promising approaches. Change elements include: the political myth in which politics are believed to be holding back the development of CAI, the conflict over the best use of CAI, the effects of CAI, and the speculative nature of CAI. The lack of communication is a source of the reluctance to change. There is poor dissemination of results, a scarcity of good demonstrations, and a lack of knowledge of the potentials of CAI. This lack of communications also allows the computer to continue to be a world that is unknown to educators. The fear that they have as a result is: of change, of computers and terminals, of radical departure from traditional education, and that man will become a tool of his tools. The lack of communication also contributes to the feeling that authors see as excess standardization, dehumanization, and a threat to individuality. The lack of communication also contributes to the lack of acceptance of the computer in general. In fact, instructional technology as a whole is poorly accepted. The teacher is seen by educators as a total instructional system in spite of the technology of books and chalkboards that they traditionally use. There is low motivation for change and disagreement about the usefulness of CAI which results in either a "wait and see" attitude or the view that CAI is merely an addition to the educational process.

The emphasis of solutions for the Attitude category is psychological change. Techniques for changing attitudes about CAI are presented by some authors. Other authors emphasize the use of the computer only when it is the best method, or making the contributions with the computer that it makes possible. Another suggestion is that research into the relation between knowledge and attitudes be undertaken.

Subcategories for the Attitude category include Community, Administration, Teachers, and Students. The emphasis, of course, was on teachers, but that emphasis was negative. The only positive comment within the Attitude category is about students. The coverage for this entire set is light.

The Community Attitude had the problem that there is an image of the computer programming the student. The problems are that society does get what it wants; therefore, a re-evaluation of social assumptions for education is needed. The general solution is a public relations program.

For the Administration category the fear of competition with administration is the negative factor while the problems are presented in terms of the effects on the organization, especially the power structure. The solutions emphasize redefinition of the administration role, and data that CAI could make available to the administration.

The attitude that is reported for Teachers indicates that either a new teacher role will develop or media will begin to compete with the teacher. Teachers are said to fear replacement, loss of affection, loss of status, and students who know something they don't. Thus there is a lack of involvement and teacher acceptance due to

ignorance of the potentials that the computer offers. This causes media to be used as add-ons and innovation to be poorly accepted by teaching areas. Some authors feel that this is due to the teacher's conception of teaching. Solutions that are presented include: release the teacher from routine activities (which the computer can do), change the teacher role, and gain teacher acceptance. Some authors note that there are teachers that should be replaced by machines.

Student attitudes have the positive value that the computer can allow student input. The problems include the possibility of stimulus deprivation, addiction to the computer, competition, and interest in the computer rather than the subject. The effect on conduct could also present problems. Solutions include communicative relationships with extra-human entities in which the impersonal nature of the computer can reduce tension in some students.

The next major category under the Teacher category is Experience with the Computer. The emphasis is negative in this category while the entire category is poorly represented in the literature. The value that experience can have is in helping to establish long-term feasibility. The negative aspects are that there is little nonvicarious experience with actual CAI systems, that there is poor distribution of use and that utilization needs to be better. The solutions include field tests and the production of a continuous "Hawthorne experience" with CAI.

The subcategories within the experience category do not appear in the literature. However, the experience with the computer is indicated by the Time a Language is Known and the Number of Programs Written. A large number of programs per unit of time implies active

development of computer applications. Classroom Use Amount is the important factor revealing computer experience for a teacher. Here heavy use indicates that resources are available as well as interest.

Administration

The next major category is Administration. This category is supported in the literature by negative aspects and solutions mainly with almost no positive aspects. The infrequently cited positive aspects are that the computer can reduce costs and that federal aid may be available to support computer use. The emphasis of the negative problems is on organizational principles. The authors noted that the educational system is designed for stability, exhibits institutional rigidity, and is characterized by local autonomy. They feel that the gap between organizational and human needs is maintained by bureaucratic complications. Thus the organization is resistant to change although some authors feel that educators are too quick to accept generalizations. Basically, the resistance to change is probably due to the many educators who feel the computer does not conveniently fit the current educational structure. The negative aspect of cost was deliberately deemphasized by this author, but the combination of high cost of computing and inadequate staff and financing along with the difficulty of calculating benefits from CAI affects administrators.

The solutions presented for the Administration category emphasize planning the integration of CAI into schools. The authors say that it should be planned as an innovation program and that innovation requires a conscious design. They also say that a value comparison needs to be

established so that the value of the computer in instruction can be shown. Many ideas are presented for trying CAI. Authors also feel that there is a requirement for costs to be reduced or at least be the same as traditional instruction.

The subcategory of Support of the Teacher within the Administration category has its emphasis on solutions and little representation of positive aspects. The positive values of the computer in support of the teacher are clerical duties, information handling, and the possibility of information exchange. The negative aspects include a lack of effective training programs, a lack of empirically validated theory, a lack of incentives, the feeling that the teacher is not the best producer of materials, and the fact that psychologists are not studying instructional problems.

The solutions in the Support of the Teacher subcategory begin with training educators to use the computer. One investigator finds that educational technology skills are best for supporting use of the computer while another says that the skills to use CAI include: operation of a terminal, the ability to program instructional materials, and mastery of the subject. User groups, professional organizations, and other means of sharing information support training by providing a means of sharing information and the results of development. Cooperation along with better status for CAI can result from such communication. Many articles emphasize the need for a team effort in writing materials.

There are three subcategories within the category of Support of the Teacher. These are Money, Released Time, and Resources Available. The emphasis in the literature is on Resources Available while the

positive aspects are poorly represented.

The category of Money within the Administration Support of Teacher is poorly represented, probably because it is assumed that if money were available for computing it would automatically be extended to the teacher. The negative aspects are that rapid change is expensive and that funding policies don't usually reach the teacher. The problem is that there is a vicious circle in which a demonstration is required in order to get money but the demonstration can't be produced without money. The solutions include incentive mechanisms to encourage computer use and material writing. One author feels that financing would affect motivation, investment of risk, and management of research.

The Released Time category is lightly covered. The problems are that released time is needed for teachers and that time is required in order to develop materials. The only solution in this category is that authors need time to develop materials.

The Resources Available category has quite a few solutions. The positive values are that the computer can handle routing and scholastic paperwork. The negative aspects are that unpublished literature dominates and that there is not interchange of either programs or information. The solutions suggest that additional personnel such as instructional programmers, authors, and producers be made available to teachers to support CAI. Resources that they should have included teaching models, experience in the subject area, training requirements and complementary roles for subject matter and computer specialists. The technical support includes special purpose computers and a central facility for software interchange. These resources should be available for a long term project.

The second major category within the Administration category is Support of Computer Use. The emphasis in support of computer use is solutions with negative aspects almost as high: but there are no positive aspects. The problems in the Support of Computer Use are the tendency to emphasize hardware, the hidden limitations of the computer, the lack of efficiency, the lack of production/distribution systems, and the shortage of qualified personnel. The solutions emphasize the technical aspects such as hardware. They indicate that the system should be service oriented, flexible and adaptable, congenial, simple, efficient, and reliable. Commercial consortiums are recommended as means of access to the computer. In any case careful coordination is needed and the computer should be fully utilized.

Accessibility as a category is represented in the literature only by solutions. The network approach or information networks are suggested. Authors also recommend that easy system access to all modes should be available and that the full power of the general purpose computer should be available at all times.

The Turn-around subcategory of the Accessibility category also is represented only by solutions. The authors seem to feel that the computer operator affects the responsiveness of the computer.

The Assistance subcategory of Accessibility is represented in all aspects although the emphasis is on solutions again. The values the computer has include bookkeeping and reduction of debugging time. The problems are inadequate teacher preparation, lack of manufacturer interface with teachers, and a lack of comprehensive consultation. The solutions emphasize personnel such as computer programmers and analysts, and media consultants. The authors felt that the faculty do not

have time for creating programs. The types of assistance the authors feel is needed include optimization of programs and debugging. Some feel that computer aided programming would help the teacher.

The Interaction With the Computer subcategory for Accessibility has many solutions and few negative aspects in the literature. The emphasis of the positive aspects is on the fact that the computer provides information or data processing in which rapid and objective manipulation of large amounts of data is possible. The results could support formative curriculum development. The negative aspects emphasize the need for a better interface, and include the difficulty of describing the work to be done in computer terms as well as the media selection difficulties.

The solutions emphasize the technical aspects of computer use. Some authors feel that the distinction between the computer and peripheral hardware will become blurred. There is considerable literature that discusses man-machine factors such as display characteristics, levels of computer involvement, and physical aspects of the interaction locations.

The Operating Policies subcategory of Accessibility has two subcategories: Scheduling and Terminal Time. All three are represented in the literature only poorly and only in solutions. Operating Policies is represented by location of the computer access. Scheduling is represented by the feeling that the computer should be available all the time. Terminal time is represented by the solutions that: more terminals are needed and home terminals should be available.

The next category within the Support of Computer Use category is the Amount Available on the Computer. This category has considerable

representation in the literature with the negative aspects emphasized and little emphasis on the positive. The positive values emphasize the contributions the computer can make to research in education and the control that is possible over materials. Experimentation can use the author summaries of student and teacher activities to aid in revision of materials.

The negative aspects emphasize the tendencies that the authors feel are apparent in education. These tendencies include: seek to do what has always been done, debate in order to avoid action, one-shot demonstrations, reports with little research or experience behind them, fragmented learning theory, premature exploitation, and emphasis on the technical aspects. The "lacks" and the needs also are emphasized. The "lacks" include natural language processing, research, variables for research, curriculum design and subject matter structuring, standardization, and experience. The needs include responses to the "lacks" and include also: definition of behaviors to be taught, distribution, reliability, ease of use, relevance, instructional development teams, and long-range total-system planning. The limits that are placed on developing new materials include: lack of computer possibilities, means which are beyond the needs, CAI is in the research and development stage, too little is known about learning, and the "seductiveness of rigor" (Mesthene, 1970, page 389).

The emphasis of the solutions is on writing and revising materials. There is a debate concerning whether computer experts or subject experts should write materials. The result has been recommendations that a team approach with role differentiation be used for cooperative development of materials. Several trials and revisions are felt to be

needed and again a team is recommended for revision. A learning theory or at least a theory of instructional optimization should support the development of materials. This approach would probably use more unobtrusive measures than obtrusive measures. The authors feel that a large research project is needed for such things as validating the effects of teaching patterns on the implementation of CAI.

The first subcategory for the Amount Available on the Computer category is Size. There are only solutions in this category and they indicate that size should be considered. The Speed category for the Amount category has no references in the literature.

The Resources subcategory within the Amount category has its positive and negative aspects and solutions about equally represented in the literature. The positive aspects emphasize the value that developing instruction can have for the developer in learning how to conduct instruction. In addition, the resourcefulness of the user is given as the only limitation. Another value is that the computer can serve as an information source. The negative aspects note the tendencies to promise more than is deliverable, for materials to be incompatible, and to feel that the computers used with CAI are designed for instruction. The lack of materials and software that fit the medium are also noted. The solutions include cumulative development of software, strategies, and various levels of CAI. A series of specific solutions that have been used is also presented.

The first subcategory for the Resources subcategory is Languages. Positive aspects do not appear while negative aspects and solutions are equally represented. The emphasis of the negative aspects is on the feeling that the computer understands only letters and numbers and

that there are no simple author languages. The feeling that there is one best CAI language is a problem as is the tendency to produce superficial language differences. The solutions refer to text-processing and other programming languages in both compiler and assembler forms. The authors note that the language reflects the nature of the communicators and that languages should make the computer approachable on the educator's terms.

The Known subcategory of Languages is not represented in the literature while the Possible subcategory is lightly represented in terms that are either negative or solutions. Authors felt that there is a lack of software as well as a lack of evidence that any will be available. The solutions basically are that a simplified and standardized programming language is needed.

The next subcategory for Resources is Programs Available which emphasizes the negative aspects and proposes few positive aspects. The emphasis of the positive is on theory. The computer is seen to be a catalyst for formalizing theory, validating theory, and producing new concepts of learning and teaching theory. The negative emphasis is that good materials are lacking and that few personnel know both the computer and education. The resulting temptation to settle for less as well as the lack of interdisciplinary emphasis are presented as hurdles that must be overcome. The emphasis on optimal course sequencing, small step programs, and minimal error rates is said to be short-sighted. The lack of evaluation criteria causes premature evaluation that asks the wrong questions.

The solutions for the Programs Available category indicate that an open-ended development strategy with many participants is a good

alternative. Some authors feel that publishers should create the materials although all feel that research and development is needed to support any production of materials. They feel that a well-defined set of appropriate training objectives should be used in the development of text materials, instructional formats, curriculum material, and instructional strategies. This would produce more applications and programs which teach well.

The next subcategory for the Resources subcategory is Storage Ability. There are few negative aspects in this category. The positive aspects are that the computer could serve to remember problem solving techniques, support information flow through remote storage of data, and collect systematic data such as records of the reception of the materials. The problems are that data storage requires memory space and immediate access requires core storage. The solutions are that virtually unlimited memory is possible while vast data files can be available. The use of mini-computers would require an exchangeable medium for them.

The next subcategory for the Resources subcategory is Access Ability which has its heaviest representation in solutions and has no negative aspects. The positive aspects are that on-line and multiple-access are available. The solutions emphasize characteristics of terminals or visual displays. Such decisions about display output as alphabetic versus graphic, paper or film, permanent or temporary must be made.

The Interview Schedule

The interview schedules are shown in Appendix A. The questions

were written from the paradigm (Figure 1) to gain the information indicated by each item of the paradigm. The questions were then reorganized in groups that had common characteristics and that progressed from objective answers to more and more subjective answers. This organization encourages the interviewee to look at the situation in an objective manner before attempting to create subjective responses. The ordering was done both with the groups of questions and within groups of questions.

As a result of the reorganization and regrouping, further questions were suggested. After determining that they would contribute to the paradigm and interview, they were added to the interview. An important addition was the group of questions that allowed the interviewee to analyze the interview itself. The relationships of the questions to the paradigm are shown in Figure 2.

Teacher Interview

On the teacher interview, the groups of questions are as follows. Questions 1 through 3 determine whether the person uses the computer and whether he desires to use it for instruction. Questions 4 through 7 determine the characteristics of the teaching done by the teacher. Questions 8 through 10 determine how much the computer is used in classes. Questions 11 through 14 determine how the teacher feels concerning released time and whether the teacher uses it for computer instructional development. Questions 15 through 19 and question 37 determine how the computer is used with students. Questions 20 through 23 determine what the teacher thinks is the interaction style of computer programs that he has written. The terms used present

Amount—1
- Time Used-
  - Creation of Materials—8, 11, 12
  - Teacher in Classroom—10
  - Student Individually—16, 17
- Number of Courses—4, 6, 7, 9
- Number of Students—5, 15

Teacher—
- Support—
  - Number of Computer Applications—18, 19, 37
  - Interaction Style—20-29
  - New Ideas—34-36
  - Ways Computer is Used—
    - Instruction Types—30
    - Logic Complexity—31-33
    - Language Level—38, 39
- Attitude—2, 3, 13, 14, 42-56
  - Community—2, 3, 13, 14, 42-56
  - Administration—2, 3, 13, 14, 42-56
  - Peers—2, 3, 13, 14, 42-56
  - Students, 2, 3, 13, 14, 42-56
- Experience with Computer—
  - Time Language Known—40
  - Number of Programs Written—41
  - Classroom Use Amount—10

Administration-
- Support of Teacher-
  - Money—26
  - Released time—
  - Resources Available—3-5, 27, 28
- Support of Computer—
  - Accessibility—
    - Turn-around—7
    - Assistance—13, 14, 25
    - Interaction with Computer—6
    - Operating Policies—
      - Scheduling—8, 11, 12
      - Terminals—
  - Amount Available on Computer
    - Size—1
    - Speed—1
    - Resources—
      - Languages—
        - Known—20
        - Possible—21
      - Programs Available—22-24
      - Storage Ability—15-17
      - Access Ability—2, 9, 18, 19
      - Other Hardware—10

Figure 2. The Paradigm Related to the Questions of the Two Interview Schedules. (Numbers are those of the questions asked. See Appendix I).

extreme positions using words that imply ways a teacher might interact with a class or a student. They are left undefined here and have no connection with any communication model. Questions 24 through 27 determine what the teacher thinks is the interaction style of his or her normal classroom activities. Questions 28 through 33 determine what the style of use of the computer in the instructional process is. Questions 34 through 36 determine the programs that the teacher would like to write or have available. Questions 38 through 41 determine how much programming experience the teacher has. Questions 42 through 51 determine what the teacher feels is the level of awareness and corresponding general attitude of the significant others called community, administration, other teachers, and students. These are the subjective view of the teacher with no apparent objective basis. This subjective answer indicates the teacher's own attitude and the effect others have on it. Questions 52 through 56 are open-ended and seek subjective information about what the teacher feels about the computer. Questions 57 through 62 are used to find out what the teacher sees as the strengths and weaknesses of the survey and also what they would add or change.

Before interviewing started, the questions were coded so that teachers who would not be able to answer certain questions would not hear those questions. This was accomplished by placing a "D" beside those questions that only the teachers who did not use the computer could answer, a "U" for those only users would answer, an "A" for those all teachers could answer, and a "Y" for those that were to be answered only if the preceeding question was answered "yes."

Administrator Interview

On the administrator interview, the groups of questions are as follows. Questions 1 through 3 determine what computer equipment is available. Questions 4 and 5 determine how the equipment is being used. Questions 6 through 8 determine the characteristics of the turn-around time. Questions 9 and 10 concern the ways that information could be sent to and received from the computer. Questions 11 and 12 concern the availability of the computer for teachers. Question 13 concerns the assistance that a teacher could get for using the computer. Questions 14 through 19 determine what resources are perceived as needed by the teachers and what resources are made available for the teachers. Questions 20 through 26 determine how the resources of the computer are used to support instruction. Question 27 concerns how much money is available for teachers to use in instruction. Questions 28 and 29 concern the computer utilization for administration and for instruction. Questions 30 through 32 will allow the administrator to react to the interview schedule and suggest improvements for it.

CHAPTER IV

CASE STUDIES

Methodology

The Sample

Since this investigation was to develop a paradigm indicating factors that affect the use of the computer for instruction, the sample was selected to include mainly teachers who had used the computer in instruction. However, since it is important that a comparison be made in order to separate computer users and nonusers, as many nonusers as possible were included in the sample. In addition, the sample was selected to include as wide a representation as possible of all subjects taught in the schools.

The actual sample (Table I) was based on convenience as a result of the decision to interview computer users. There were so few users in Wichita that those that would cooperate were interviewed while the sample in Shawnee Mission was large enough that it could be randomized and those that would not cooperate were replaced by subjects who were available. The nonusers were selected to maximize the coverage of subject matters and were a convenience sample within that.

The sample of teachers in Wichita was selected to include 22 computer users and 10 nonusers. The actual proportions were 21 users and 11 nonusers, since there were teachers that had been expected to

TABLE I

SAMPLE

	Selected	Actual	Mathematics	Science	English	Social Studies	Physical Education	Vocational	Total
W	22	21	17	13	0	3	0	0	33
S	14	15	9	10	8	0	0	1	28
WN	10	11	35	7	6	10	1	6	65
SN	5	4	3	0	9	0	0	2	14
T	51	51	64	30	23	13	1	9	140

The number of different courses being taught by each teacher is accumulated under the subject headings. Thus, there were 140 different subjects taught by the 51 teachers interviewed. A distinction between Algebra I and Albebra II qualified as a subject change for these data.

be using the computer who were not and others who were using it that were not expected to be. The administrator who knew about the use of the computer in Wichita answered the administrator interview.

The Wichita sample was also selected to include a broad coverage of subjects. The actual sample was mainly mathematics and science teachers. However, English, psychology, sociology, and physical education were included.

The sample for the Shawnee Mission Public Schools was selected to include 14 teachers who used the computer as well as five nonusers. There were actually 15 teachers using the computer and four who did not. Again, there were teachers using or not using the computer despite expectations. The sample included teachers of mathematics and science mainly with a good representation of the humanities courses. The business and technical courses were poorly represented.

The Interviews

The interviews were performed by the author personally with each subject. Each interview was done as nearly on a one-to-one basis as was possible. However, some interviews in the Shawnee Mission schools were attended by the Coordinator. Most interviews were conducted during the planning period for the teacher although one day was a professional day in Shawnee Mission and scheduling was less restricted.

The interviews were conducted on Fridays and Mondays due to the other obligations of the researcher. They were conducted mainly in November, 1974. A few preceeded and a few followed that month.

The interviews in Wichita were arranged through the building principals. The arrangements ran from an okay to do the research in

the building to arranging appointments and insuring that teachers made them. The Shawnee Mission arrangements were handled by the Coordinator who went with the author to most of the schools. Generally, teachers in Shawnee Mission had no warning that they were to be interviewed and some that were scheduled were missed as a result.

Wichita Case Study

Background

Robert Wright (1974), a mathematics teacher at North High School, talked to Dr. Alvin Morris, Superintendent of Wichita Public Schools in August, 1970 in order to ascertain if any plans were being made for the use of computers in the classroom. Dr. Morris answered that there were none and gave Wright the authority to proceed making plans for using the computer. Wright proposed a pilot program to the Board of Education in February or March of 1971, but there was no specific response since it was presented as part of the Data Processing Division proposal for an IBM 360 computer.

In August, 1971 Wright presented another proposal to the Board of Education with the support of the Superintendent and it was passed. The authorization was for a pilot project at North High School with up to $7000 ($300 for books and $6700 for computer services) of support. This money was used to support instruction in two Algebra II classes at North using two computer terminal (one on-line and one off-line with paper tape). These terminals were connected to the computer at Southern Methodist University in Dallas, Texas. The $6700 was used to purchase 1000 hours of connect time from SMU.

In the spring of 1972, Wright asked the Board of Education to purchase a Hewlett-Packard 2000A computer (HP 2000A) for instructional use only and they agreed. He then negotiated with Hewlett-Packard to send an HP 2000E for the price of the HP 2000A and they agreed. Due to development problems with the HP 2000E, it could not be delivered on schedule. After nine weeks of school, they loaned mini-computers to North and South High Schools. The Research and Evaluation Services Division published an evaluation report about the computer extended instruction (CEI) pilot project in September, 1972 (Wright, 1972). This evaluation revealed that the CEI sections were particularly successful in maintaining enrollment and in motivating student interest in mathematics courses. However, the student achievement was lower than that with the regular classes. It is thought that the less traditional curriculum plus the late delivery of the computer might account for these results.

Wright worked with Dr. Michael Tilford of Wichita State University during the spring and summer of 1972 on a proposal to get the National Science Foundation (NSF) to provide funds. They received the grant and spent time during the next school year to get the project underway.

In June, 1973, the HP 2000E computer arrived. In August, 1973, an NSF institute was conducted for 24 high school mathematics teachers. During the 1973-74 school year, the project expanded to all of the high schools with 19 terminals. A study by the Division of Research and Evaluation Services was published in December, 1973 (McCarty, 1973), which reported the extent of usage of the HP 2000E during the period from November 12 to 16, 1973.

The Final Report (Tilford, 1974) for the NSF grant was published after May of 1974 by Tilford and Wright, who reported that the objective to develop, in teachers, the use of the BASIC language for computer programming, was successfully attained; and that the student attitude with respect to Algebra II changed in a positive direction, but this tendency was not statistically significant. They also reported that the achievement of students using the computer curriculum for Algebra II was significantly greater than that of students taking Algebra II without the computer as a tool. They also detected the implication that the computer was particularly successful as a modeling device when more difficult Algebra II concepts were involved.

Another NSF Institute was conducted in August, 1974, in which the science and social studies teachers were represented. Robert Wright has sent a new porposal to NSF, but no response was known by December, 1974.

Teacher Interviews

The results of the interviews of the Wichita teachers are summarized in Tables I-X. They revealed the following. There were 21 teachers interviewed who had used the computer as an instructional aid while 11 had not. Further, there were 24 who currently desired to use the computer as an instructional aid and eight who did not. Of the teachers who had not used the computer as an instructional aid, nine would like to use it if they were given appropriate circumstances while two would not.

The teachers interviewed taught an average of 4.74 class periods per day. One did not teach while one taught three and one taught six periods. The average number of students taught was 125.6 with a minimum of 50 and a maximum of 187.

The subjects taught (see Table I) included algebra (20), geometry (16), accounting (5), physical science (5), physics (4), trigonometry (4), English (4), aeronautics (3), everyday math (2), basic math (3), calculus (2), biology (2), chemistry (2), psychology (2), human relations (2), analytic geometry (2), and one each for business math, record keeping, astronomy, introductory algebra, cinema, photography, English on the job, general math, geology, girls' physical education, history, current events, U. S. history, world history, international relations, sociology, and advanced chemistry. The subjects in which the computer was used included algebra (10), physics (4), physical science (3), trigonometry (3), psychology (2), and one each for astronomy, biology, general math, chemistry, aeronautics, pre-algebra, elementary algebra, geometry, zoology, sociology, and advanced chemistry.

The teachers spent about 5.35 hours per month using the computer in preparing materials for instruction. They use the computer as an instructional medium in an average of 2.56 classes. Teachers spend an average of 2.66 hours of classroom time per month presenting materials that were stored on the computer for classroom use.

There were 19 teachers who felt that they were given no released time for the development of instruction while 10 felt that they were given 20 or more hours per week (their planning period). Of the teachers who said they use the computer, 15 said that they were not given any released time for the development of instruction that uses the computer as an instructional medium. There were no responses recorded for the other six. There were two teachers who said that they had been given released time for the development of instruction that uses the computer as an instructional aid at some time while 17 said

that they had not. The two who said they had been given released time to develop instruction using the computer clarified their position by saying that they were referring to their attendance at a workshop for the purpose of learning to use the computer in algebra classes as released time. Further, 21 teachers said that they felt that released time would be necessary for them to use the computer as an instructional medium while nine said that they felt it would not. Their comments ranged from helpful (6), in order to use it more effectively (3), only for a workshop (3), to get training that is needed (2), and one each for using prepared materials eliminates it, new materials would require it, maybe, desirable, beneficial, depends on the materials available, and in order to use it adequately.

The average number of students using the computer as an instructional medium in these teachers' classes was 51.06 with a range from 12 to 100. The average time that the average student works on the computer for their classes per month is 6.21 hours with a range from 0 to 50 hours. The total amount of time that all of the students in classes of the teachers who use the computer work on the computer per month was 83.76 hours with a range from 0 to 380 hours. The number of different computer programs suggested by a teacher for students to use per month, on the average, was 12.25 with a range from 0 to 50.

Teachers characterized the interaction style of their computer programs as open-ended (8) rather than closed (1) or midway (1). They also characterized their computer program interaction style as a friendly conversation (5) with three who were midway and two at formal presentation. In addition, they characterized their computer program interaction as student-oriented (7), rather than midway (2) or presenter-oriented (1).

Teachers characterized their own teaching interaction style as open-ended (16), rather than midway (9) or closed (6). They also characterized their interaction style as a flexible presentation (20) rather than midway (7) or strict flow (4). They were almost split on their interaction style characterization with friendly conversation at 13, midway at 10, and formal presentation at eight. Further, teachers were split on their interaction style characteristics with student-oriented at 10, midway at 10, and presenter-oriented at 11.

The average of the percentage of computer use in the classroom as the object of instruction (learning about the computer) was 15.13% with a range from 0% to 99%. The average of the percentages of computer use in the classroom as the medium of instruction (learning through the computer) was 60.39% with a range from 1% to 100%.

The types of instructional programs used on the computer are problem solving (15), simulation and games (14), student programming (12), tutorial (6), dialog (6), managing instruction (6), problem generator (6), inquiry (6), drill and practice (4), and diagnostic and testing (2).

The average of the percentages of the programs that the teacher writes that present material only is 20.93% and the range is from 0% to 100%. The average of the percentages of programs that react to student input is 63.57% with a range from 0% to 100%. The average of the percentages of the programs that adapt using student history as well as responses is 1.92% with all responses at 0% except for one at 25%.

There were 19 teachers who had programs in mind that they had not yet implemented and 13 who did not. The programs that teachers had in mind included many that were enhancements of present materials (12), and

additional simulations (11). In addition there were management programs (2), statistical analysis programs (3), and one each for career resource lab, interdisciplinary curriculum, tutorial library programs, solving equations, drills, statistical models, Huntington science curriculum materials, graphing, other curriculum areas, more CAI, more CMI, and data storage and analysis. They felt that the following would enable them to write these programs that they had in mind: time (12), more equipment (3), finding an application (2), learning about programming (2), interested students that understand the problem (2), and deciding to write them (1).

The average of the total number of computer programs that the teachers knew were available for them for instruction was 50.96 with a range from 0 to 600. The number of programs written by the teachers averages 14.78 with a range from 0 to 33 although one wrote 100.

The computer languages known by teachers are BASIC (22), FORTRAN (9), and one each for WIPLE, SPS, and ALGOL. The languages that teachers who program use are BASIC (21) and Fortran (1). Computer using teachers have been programming with BASIC an average of 7.47 years and FORTRAN an average of 6.28 years. They have written an average of 67.11 programs with BASIC with a range from 2 to 250. The FORTRAN average is 115.71 with a range from 5 to 650.

Teachers felt that an average of 14.26% of their community were aware of the use of the computer as an instructional medium with a range from 0% to 90%. There were 10 of these who felt that the community was very positive, 11 who felt that they were positive, and 11 who felt that they were neutral. The portion of the administration that the teachers felt was aware of the computer as an instructional

medium was 79.63% with a range from 0% to 100%. There were six who felt that the administration was very positive, 18 who felt that they were positive, and eight who felt that they were neutral about the use of the computer as an instructional medium. Teachers felt that an average of 50.74% of the other teachers were aware of the computer as an instructional medium with a range from 5% to 100%. There were two who felt that other teachers were very positive, 20 who felt that they were positive, nine who felt that they were neutral, and one who felt that they were negative about the use of the computer as an instructional medium. The portion of the staff that is aware of the computer as an instructional medium was 48.74% with a range from 0% to 100%. There were two who felt that they were very positive, 14 who felt that they were positive, 11 who felt that they were neutral and one who felt that they were negative. Teachers felt that an average of 41.03% of the students were aware of the computer as an instructional medium with a range from 0% to 100%. There were nine who felt that students were very positive, 16 who felt that they were positive, and seven who felt that they were neutral.

Teachers saw recognition for using the computer in instruction as possible (23). However, there were nine who felt that it was not possible. The positive possibilities for recognition included ego-building (11), getting publicity (11), and being pioneers (9). Responses also included "possibility," "increased availability," "improving work of others," "discovery," "releasing teacher time," and "influence." On the negative side, they said such things as "none for the teacher",(3) "not really" (3), "little" (2), "doubt it" (2) and "the teacher shouldn't expect it." Many felt that the only recognition was for

the student. Student possibilities were included above, but those unique to the student included: future oriented ideas (3), open a new field for students (2), and one each for competitions, presentations, and mark on transcript.

The things teachers who were not using the computer felt would make it possible for them to use the computer in instruction include: training (6), and more equipment (4), with three each for awareness of possibilities, feeling that it was useful, and having programs available, and one each for money, smaller classes, cadet teachers and released time.

The comments concerning the educational impact that the computer can have included "great," "fascinating tool," "tremendous," and "positive," as well as "it may be a gimmick." In addition teachers felt that the impact could be understanding the computer age (9), students learn through teaching (6), individualization of materials (6), time-saving (5), motivation (5), only as a tool (5), remediation (2), and great variety of uses (1). Other comments of interest included that the student can compete with the problem rather than with people, and it is a supplement to the teacher rather than a replacement for the teacher.

Teachers said that if they were given anything that they needed in terms of time, money, and equipment in order to use the computer as an instructional aid that they would use them: to purchase more equipment (16), to place more subject materials on the computer (11), students to use the computer more (8), to learn about using the computer (7), to store and retrieve information for and/or about students (6), to present materials for students (5), to make simulations available for students

(4), to increase the amount of CEI materials that are available (4), to create individualized materials (3), to support other activities as a tool (2), with one each for placing materials on the computer, relating computer languages to spoken languages, placing remedial work on the computer, supporting research activities, and supporting systematic analysis of subject matter to determine what will work best with computer presentation. One teacher stated that the imagination of the teacher was the only limit.

There were 23 teachers who noted a question in the interview that seemed exceptionally good and nine who did not. There were eight who felt that the open-ended question about unlimited resources (no. 56) was good, five for the student awareness questions (nos. 50 and 51), three for the educational impact question (no. 55), and one each for: the non-user question "would you like to use the computer" (no. 3), the questions about released time (nos. 11-14), the questions about the actual use of the computer (nos. 15-18), the question "how many programs do you know are available for your use" (no. 37), the questions about teacher, staff, and student attitudes (nos. 46-51), and the question about what would enable them to use the computer in instruction (no. 54).

There were 22 teachers who noted a question that seemed exceptionally poor and 10 who did not. There were five who selected the attitude questions (nos. 38-51), four for the interaction style questions (nos. 20-27), three felt that there were terminology problems, two felt that the times asked about were not relevant, two said that staff and teachers are the same in nos. 46-49, and one said that the educational impact question (no. 55) was too open-ended.

There were 10 teachers who had expected questions that weren't included and 22 who did not. The questions that were expected were such things as: opinion about the computer as a teaching tool (2), the use of the computer due to the bandwagon effect (2), comparison of teacher time with student time, specific uses of the computer, the influence using the computer now has on students for future use, what size computer is needed for educational use, the current cost of computing for instruction, enjoying teaching, enjoying using the computer as a teaching tool, reaction to the computer course, relation between taking the computer course and teaching using the computer, the background that caused computer use, and administrative questions.

There were 14 teachers who felt that there were questions that needed to be added and 18 who did not. The questions that needed to be added were such things as: "did students learn more using the computer" (4), "what would motivate continuing use of the computer" (3), "does the teacher feel that the computer is economically feasible" (2), "how many high schools have access to the computer" (2), "student reaction to computer instruction" (2), with one each for specific use of the computer, where would information about using the computer be available, does learning through the computer influence future use of the computer, the impact of the computer on the classroom behavior of students, how much is the teacher using the computer, and how available are the computer facilities to students and teachers.

Administrator Interview

The Wichita Public Schools have a Hewlett-Packard 2000E (HP 2000E) computer with 20 terminals for instructional purposes. They also have

an International Business Machines 370/135 (IBM 370/135) computer for administrative purposes. The Vocational-Technical schools have a National Cash Register 101 (NCR 101) computer. The HP 2000E is being used 24 hours a day. It is capable of handling 16 terminals simultaneously. It is used at about 80 percent of its capacity during the school day. The NCR 101 is used exclusively by the vocational program and is used as needed. The IBM 370/135 is used five days a week from 7 a.m. to 1 a.m. mainly for administrative processing.

There are 20 NCR 260 terminals which are connected to the HP 2000E. They are located in six high schools and the Metropolitan Secondary Education Center. There are also six HP 7260A card readers for this computer as well as two disks (one removable). The other equipment that is available for instructional use is being used. The equipment that is not currently used for instruction that could be made usable is the IBM 370/135 with proper scheduling. This would be for advanced programming courses.

The average amount of time that a user has to wait for results after presenting a program to the computer from a terminal is about two to four seconds. If the batch stream is used for the advanced programming classes, the average amount of time that a user will have to wait for results from the batch stream will be one day. The difference among various types of users in terms of waiting time for computer results is zero on the HP 2000E although students, especially in math, have priority. On the IBM 370/135, the administration has priority.

The type of input and output devices normally available to teachers using the computer is the NCR 260 computer terminal at school or at home and the HP 7260A card readers at school. The additional types of input

and output devices that could be made available for instruction are the batch card reader and printer as well as the CRT terminal on the IBM 370/135.

The HP 2000E computer is operational for teachers 24 hours a day. The HP 2000E computer is normally not available for teachers during the day since students get priority. There is also a preventive maintenance period of about 15 minutes per day.

The assistance that a teacher has in developing and producing a program for instruction by computer includes the Hewlett-Packard library, the local math organization, a course at Wichita State University, the National Science Foundation Workshop each summer supporting the CEI materials, and part-time assistance from the staff with programming and hardware on an as-needed basis.

The restrictions placed on a teacher wishing to use the computer are that students get preference, and that the teacher must get clearance from the computer center with verification from the curriculum center in order to use the computer.

The active space that is normally available for teachers using a terminal is 50 sectors of 400 characters each. The amount of on-line storage space that is available on the computer for teachers is about 5.6 million words (four characters per word), i.e., all they need. Any teacher can store for immediate use (on-line) on the computer up to 50 segments automatically, but more is possible.

The computer access time for normal runs on the HP 2000E is two to four seconds for running with a 30 character per second transmission rate to the terminal while the transmission rate for the CRT terminal on the IBM 370/135 is 2400 baud which is 300 characters per second. The

computer access time for teacher runs is the same as the HP 2000E times.

The teachers generally know the computer language BASIC. The languages available for the teachers to use are BASIC, ANS COBOL, FORTRAN, and Assembler.

The number of programs available for teachers to use is about 1500. All of these programs are normally available on the terminal for teacher use. Likewise, all of these programs are available for a teacher on-line. Computer-ready programs that are not implemented on the computer can be made available for teachers to use after the approval time and documentation time. It could be immediate with a program on paper tape or within a week in any case.

The amount of money that is allocated to the use of the computer as an instructional medium is $48,000 for the HP 2000E and $28,000 for the IBM 370/135.

The percentage of the computer utilization that is administrative is 95% on the IBM computer and 0% on the Hewlett-Packard computer. The percentage of the computer utilization that is instructional is 100% on the Hewlett-Packard computer and 5% on the IBM computer.

The questions that the administrator noted that seemed exceptionally good were those concerning availability of the computer for teachers and students (nos. 8 and 12). The questions that the administrator noted that seemed exceptionally poor were those about access time (nos. 18 and 19). The questions that the administrator expected that weren't included concerned the definition of CAI and computerized instruction, and the type of computer instruction being used. The question that the administrator said needed to be added was a recommen-

dation concerning languages for computer instruction.

Shawnee Mission Case Study

Background

In the spring of 1967 (1966-67 school year), a representative of the Monroe Division of Litton Industries indicated that his office would be willing to make the facilities of their demonstration computer, the Monrobot XI, available to high school students. An evening seminar in the Shawnee Mission schools was taught by Denis McMahan (1974) which established teacher interest in using this computer to start a new student club. Project SLOPEC (Students Learning to Operate and Program an Electronic Computer) resulted, in which between 15 and 40 students participated after school in learning to program the computer. This included field trips to the Monrobot computer to run their programs. A summer school course in computer mathematics developed due to the interest generated by this club. The Monrobot computer was rented for a few months for the summer, 1967 course. This course had about 25 students and the second course had about 20 students who learned to program using the Monrobot computer.

There were no course offerings during the regular school year for 1967-68. An IBM 1401 was purchased in February, 1968, for administrative use. It was used in the 1968 summer school computer mathematics course since it had been installed but was not yet being used for administrative computing.

Since student interest had remained high during the 1967-68 school year, and an IBM 1620 computer had become available at a substantial educational discount, plans were drawn up for a course offering in

computer science and the facilities were prepared for the computer to be installed at East High School. The result was a computer mathematics course at East High School during the 1968-69 school year using the IBM 1620 which was installed in October, 1968. Eighty (80) students in five math clubs also used the computer. A teacher training session was also taught by Denis McMahan in which some thirty (30) teachers participated.

There were many operational problems with the IBM 1620 and by February there were problems that could not be solved. An IBM 1130 came under consideration to replace it, but the cost was substantially more than the IBM 1620. However, it was felt that more students would benefit by going district-wide. Therefore, a proposal was presented January 10, 1969, by Denis McMahan for an IBM 1130 to replace the IBM 1620 computer for the computer mathematics course. He also recommended the addition of three computer science courses to the curriculum.

During the time that the 1130 was under consideration the IBM 1401 in administration was being taxed heavily and a replacement for it was being sought and other applications were needed for justification. So the administration proposed to replace their IBM 1401 and the instructional IBM 1620 with an IBM 360/30 at no cost to instruction except terminals, lines, and controller during the 1968-69 school year.

The IBM 1620 was released and a University Computing Corporation (UCC) computer terminal was leased for the 1969 summer school. The IBM 360/30 was purchased in July, 1969, and a remote terminal system was used with it for instruction. This remote terminal system required that the computer be dedicated to instruction for about five hours per day, in the morning. This left the terminal unused in the afternoon and caused some scheduling problems for the computer science classes.

However, the system soon began to be taxed by this schedule as far as there being enough time left to do other kinds of processing, expecially during mornings where some time needed to be set aside for payroll applications, other financial applications, and needed feedbacks for the staff.

Therefore, the operating system for the computer needed to be changed. Alternatives were considered and APL (A Programming Language) was selected because of the conciseness, terminal-orientation, and user-orientation of the APL system. During the summer, Denis McMahan gained experience with the APL system in the Bingham Junior High School and developed and tested programs for use with APL. The proposal for APL was presented to the board with the option of 10, 20, or 30 terminals, and the recommendation to start with 10 terminals, expand to 20 the next year, and then to 30 the following year was approved. This plan allowed for training and preparation to use a small number of terminals so that money could be saved for the first year. During 1970, APL was selected as the alternative system. There were three teacher training sessions during that year in which about 60 teachers learned about APL and the computer.

At the end of the year, budget considerations indicated that APL was expensive and should be trimmed. However, a cost justification revealed that the five hours of dedicated time was expensive. Therefore the free system turned out to cost $145,000 while APL would cost about $100,000. In addition, the system had benefited only the computer science program which made the cost about $200 per student. On the other hand, APL could benefit other courses as well. Further, the previous system eliminated the possibility for growth. With the coming

of this budget lid, there was no possibility for growth of the APL system either. Therefore, in 1971, the 20 terminals could not be purchased.

During the second year, the investment of the computer resources was in terms of capital rather than production. More teachers were trained and more materials were produced so that when more terminals were made available there would be even more teachers and materials available for use. During the first two years, one of the other terminals was used to show elementary schools some of the applications that were avilable. There were quite a few applications suggested by the elementary teachers as feedback. During the 1971 school year, Cecil Denney expanded the APL library and developed a special school management system and built a system of test questions which he had previously been using with the batch processing system. This system was designed to relieve teachers of some of the burden of individualizing curriculum by preparing multiple tests.

The budget was again tight in 1972 and the 20 terminals again did not get purchased. However, Ron Converse joined the development of the Curriculum Management System (CMS) and started adding objectives to it. He presented objectives as being needed so that one would know that the tests were measuring competence on the same objectives so that equivalent tests could be produced. These were added to the test question package that Cecil Denney had started and was still working on. A number of people became interested in the prospects for CMS and by the end of the summer it was a smoothly running system. A lot of people wanted to use it. Biology and chemistry materials were being developed and some geometry materials were started. Provisions

were made to speed up the operation of CMS for the next year.

The Citizen's Data Processing Advisory Committee was selected in 1972 for the purpose of recommending future use and equipment for the computer activities. This committee of patrons of the district was to survey computer needs and capabilities. They recommended that a larger system be made available and that more terminals be placed in the schools for instructional purposes. This was a ratification of the administration proposal. At the board meeting of May 22, 1972, the Data Processing Department presented a report indicating that there was an overload situation in data processing. The administration recommended that an IBM 360/50 be leased from the Boothe Corporation to replace the IBM 360/40 that was being used. During the July 24th meeting the board decided to lease the IBM 360/50 and retain the same peripheral equipment. On September 15, the board approved a letter of intent for an IBM 370/135 with a requested installation date of September 1, 1973. This was contingent on funds and was in accordance with the recommendation of the Citizen's Data Processing Advisory Committee which had been appointed by the board and the recommendations made by the Data Processing Users Committee of the district.

However, there were still only 10 terminals used for instruction again in 1973. By this time, CMS was running smoothly and workshops were being held in which materials for CMS were being developed. Computer use focused on CMS. An Arthur Anderson audit was made to recommend improvement in the use of the computer. They recommended a shift of the entire CMS package to BASIC and the replacement of APL with BASIC in order for the school system to economize. This study lead to the establishment of a task force to recommend computer equipment

purchases. This task force accepted input from a number of sources.

By December, 1974, no action had been taken with respect to the use of the computer in Shawnee Mission due to deadlocked votes of the school board. There is one person strongly against and one strongly for increased use of the computer. The one strongly for has disqualified himself due to his ownership of stock in IBM. He neither discusses nor votes on the issue. The other board members are split so that votes continually are deadlocked. The computer being used is a 360/40 and the 10 terminals are still being used.

Teacher Interviews

There were 19 teachers interviewed in Shawnee Mission. Of these, 15 said that they had used the computer as an instructional aid while 4 said that they had not. Further, 16 currently desire to use the computer as an instructional aid and three do not. Of the four who had not used the computer, three would like to use it if they were given appropriate circumstances and one does not want to use it. Since the sample for the research was selected to randomize users and non-users, it appears that the teachers in Shawnee Mission are interested in using the computer for instructional support. However, in the actual sample used, 12 felt that they were computer users while seven felt that they were not.

The Shawnee Mission sample included both Junior and Senior High School teachers. There were two teachers who taught only three periods per day, three who taught four periods, 14 who taught five periods, and one who had responsibility for seven in addition to teaching five, making an average of 4.74. The number of students taught ranged from 64 to 300

with an average of about 129. The sample was selected in order to maximize the coverage of subjects taught by the teachers, however, as indicated by the fact that there were 12 mathematics, 10 science, 17 humanities, and three business classes taught by the teachers interviewed.

Teachers who did not use the computer felt that it was best suited to some subject other than what they were teaching. However, the computer was being used in most subjects. There were nine mathematics classes, 10 science classes, eight humanities classes, and one business class being taught using computer materials. Teachers spent an average of 8.9 hours per month using the computer in preparing materials for instruction. Teachers used the computer in an average of 4.14 of their classes. Teachers spent an average of 37 hours per month presenting, in the classroom, materials that were stored on the computer for presentation in class.

There were three teachers who felt that they were receiving any released time for development of instruction and two of those said that their planning period was for that purpose. The other one apparently received additional time of 12 hours per month for development of instruction. Only one teacher who used the computer included the planning period as preparation time for the use of the computer as an instructional medium. The others felt that they did not receive any released time for development of instruction for the computer at some time while 13 felt that they had never been given any released time for the development of instruction on the computer. Teachers were split nine to nine concerning whether it would be necessary to receive released time in order to use the computer in instruction. Their

comments ranged from helpful, beneficial, needed, and desirable to not necessary.

Teachers said that an average of 46 students were using the computer as an instructional medium in their classes. They felt that their average student was spending an average of 3.3 hours working on the computer per month. They also felt that all of their students used an average of 79.5 hours a month.

Teachers said that they assigned an average of 3.45 computer programs for their students to use per month with a maximum of 15 per month. Also, five said that they did not make computer assignments. Only nine of the teachers felt that their use of the computer could be analyzed in terms of interaction style. There were two teachers who characterized their computer program interaction style as open-ended, three as in the middle, and four as closed. One teacher characterized the computer program interaction style as a flexible presentation, three were midway, and five were strict flow. Two teachers felt that their computer program interaction style was a friendly conversation while one was midway and six were formal presentation. There were six who felt that their computer program interaction style was student-oriented while one was midway and two were presenter-oriented. Thus, teachers felt that their computer program interaction style tended to be closed, strict flow, formal and student-oriented.

There were 13 teachers who felt that their own interaction style normally was open-ended while four were midway and two were closed. Twelve felt that their interaction style was a flexible presentation while five were midway and two were strict flow. Again, 13 felt their interaction style was a friendly conversation while four were midway

and two were formal presentation. There were 11 who felt that their interaction style was student-oriented while six were midway and two were presenter-oriented. Thus, teachers felt that their own interaction style was open-ended, flexible, friendly, and student-oriented.

The 12 who used the computer in their classroom felt that, on the average, about 17% of the use was as the object (learning about the computer) of instruction while about 61% was as the means (learning through the computer) of instruction. There were 10 who used the computer in instruction as a problem solver, six for tutorial presentation, seven for drill and practice, eight for dialog presentations, 10 for managing instruction, seven for student programming, nine for simulation and games, 11 for diagnostic and testing, nine for problem generation, and five for inquiry studies. For the 10 who felt that they write computer programs for instruction, an average of about 27% of their programs presented material only, 57% reacted to student input, and 12% adapted using student history as well as responses.

More than half of the teachers (10 to 9) had computer programs in mind that were not yet written. These generally included extensions of things that were already started. The emphasis was on simulation and games. Management processing and expansion of CMS also were mentioned frequently. They felt that the main thing that would encourage them to write them was released time. In addition, some teachers felt that additional equipment or assurance that equipment would be available would encourage them to do more with the computer.

There were four teachers who felt that there were no computer programs available for them to use while the average was 29.73 and the maximum was 175. The average number of computer programs written by

teachers using the computer averages 17.33 with a range from 0 to 55.

There were ten teachers who know how to write programs using the computer language APL while six could use FORTRAN. There were two teachers each who knew the languages COBOL, ASSEMBLER, or BASIC while there was only one who knew each of the languages PL/I, WATFOR, or COURSEWRITER. There were three who felt that the CMS package (Curriculum Management System) used in Shawnee Mission constituted a programming language that they knew. There were eight teachers who used APL for writing programs while two used FORTRAN, one used COBOL, and one used WATFOR. The average length of time that teachers had known APL was 3.57 years while the average for FORTRAN was 4.45 years and the others ranged from two months to five years with an average of 2.79 years. The average number of programs written with APL was about 101 while the average for FORTRAN was about 70. The others were generally less than 15.

The teacher's perceptions about attitudes toward the use of the computer in instruction follow. Teachers felt that an average of 27.84% of their community was aware of the use of the computer as an instructional medium with a range from nearly 0% to 100%. There were five who felt that the community attitude was very positive while ten felt that an average of 78.47% of the administration was aware with a range from about 0% to 100%. There were seven who felt that the administration was very positive while ten felt that they were positive and two felt that they were neutral. Teachers felt that an average of 49.48% of the other teachers were aware of the use of the computer as an instructional medium with a low of 7% and a high of 100%. Only two

felt that other teachers were very positive while 12 felt that they were positive and four felt that they were neutral. They felt that an average of 47.42% of the students were aware of the use of the computer as an instructional medium with about the same range. There were four who felt that their attitude was very positive while ten felt that they were positive and five felt that they were neutral in general. Generally, the attitude of those who are felt to be aware of the computer as an instructional medium was positive and the average awareness was 54.17%.

There were 14 who felt that there was a possibility for recognition as a result of using the computer in instruction while five did not. Many saw recognition as possible for students and not for teachers. Most of the recognition possibilities were for awards and honors while using the program itself was also considered to be recognition. The main recognition for teachers was publications and speaking engagements.

Those who did not use the computer felt that learning about the computer and having their class information stored on the computer would enable them to use it. They also specified that additional time and assistance would be enabling.

The teachers felt that the educational impact of the computer would be beneficial, in general. Some of the specific ways include motivation (4), individualization (4), and change of the teacher role (4). Also they felt that improved student understanding (3), time saved (3), and the support of material preparation (3) were important. Some mentioned availability as a contributing factor to the educational impact of the computer.

When asked how they would use the computer if they were not limited by time, money, or equipment most of the teachers' responses dealt with

expansion of the hardware (11), especially terminals for the students. Some wanted to add CRT type terminals while others wanted to expand the entire computer system. The other ideas were generally expansions of classroom related materials such as tests (2), student designed programs (3), simulations and games (2), problems (2), diagnostic programs (3), etc. Other noteworthy ideas were released time for teachers to prepare materials and workshops about the use of the computer for instruction.

There were 13 teachers who noted a question in the above interview (56 questions) that they felt was exceptionally good. Most specified that the open-ended questions toward the end about using the computer with no limitations (no. 56) encouraged them to think about possibilities that they hadn't considered. Others pointed out that the questions concerning release time (nos. 11-14) indicated an area that needs consideration.

There were ten who noticed questions in the interview that they felt were exceptionally poor. Some felt that the vocabulary was too difficult; it included computer terms and "educationeze." The interaction style questions (nos. 20-27) fell into this group. In addition, some felt that it was unfair for them to judge the interest of others as was requested by the attitude questions (nos. 42-51). Others felt that certain groups of questions were repetitious and that the interview was generally vague.

There were four teachers who had expected questions that were not included. The main thing they expected was more specific questions concerning the actual use of the computer and their personal attitudes about computer use in instruction. They also expected questions that

would reveal their evaluation of access to the computer, the present computer abilities, and the most valuable contribution of the present computer system. They also expected questions that would reveal problems with and trends for the computer in the Shawnee Mission Public Schools.

There were five teachers who felt that there were questions that needed to be added to the interview. There were some who wanted questions concerning evaluation techniques used by the Shawnee Mission teachers. Others wanted questions that would reveal the school board problem. In addition, they felt that student aid work should be investigated and that the amount of faculty use of the computer should be determined.

Administrator Interview

The computer equipment that the Shawnee Mission school system has is an IBM 360/40 using the DOS operating system. In addition to the batch system which runs jobs on a continuous basis in the computer room, there are two teleprocessing systems which run jobs from remote locations. These teleprocessing systems are for APL, which is used for CMS in the schools, and a library cataloging system, which keeps track of materials for the library system. The computer system is being used at 60% to 65% of full capacity.

There are nine APL terminals available in the schools and one terminal in the computer room to keep records about APL for the computer operators. There are 14 keypunch machines located in the schools for the computer science classes. In addition, there is a disc pack that is used in the computer room by the APL system which can be

considered to be available to the schools. All of the equipment that is made available for instructional use is being used. Further, none of the equipment that is not currently available could be made available for instructional use.

The user of an APL terminal, on the average, has to wait two seconds for results after presenting information to the computer. The user of the batch system has to wait 12 hours on the average (up to about 24 hours) after presenting a program to the computer before receiving results.

Generally, there is no preferential treatment given to different types of users. However, payroll processing and grade reporting could receive priority if a conflict were to arise. When APL is running on the computer, instructional use automatically has priority. So far no conflicts have occurred between different types of users.

The input and output device normally used by a teacher is a typewriter-type computer terminal. The data processing center has no other input and output devices that could be used by the teachers unless the teachers expanded their sharing of the card reader and printer in the computer room.

Teachers have access to the computer from 7:30 to 4:30 during school days through the APL terminals. They also have access through the batch stream during the evening. Generally the computer is not available to teachers on Saturday and Sunday.

A teacher can get assistance in developing and producing a program for instruction using APL through a staff person hired to support the APL system. They can also get assistance with PL/I, COBOL, BAL (Assembler), and FORTRAN through the systems programmer who is hired to

support the computer operating system. Both of these people are full-time and can be contacted for assistance during working hours. The APL support person also initiates some contacts with teachers.

The restrictions that are placed on a teacher wishing to use the computer are fairly liberal. Batch processing has no restrictions on the teachers. Teachers cannot have access to the files or records about individual students, however. They also are not allowed to operate the computer since no teachers are qualified to operate the computer at this time. Their access to the keypunch equipment and facilities may be limited also. Teachers using the APL system must describe their program parameters in order for them to be permanently stored on the computer system. Generally, they have to write their own programs for use with APL. The number of workspaces available for an individual teacher is limited to two. Generally the accounts that are assigned to teachers are for the retrieval of materials only. There is also a ceiling on the number of entries that may be put into any of the CMS pools, but this is inherent in the equipment.

The space that is available for a teacher to use in writing a program or group of programs in APL is 30,000 bytes (four characters per byte). The teachers have 4500 tracks of space available on the disk for them to use for information storage and retrieval. Each track will hold 7294 bytes of information so that the 4500 tracks will hold almost 33 million bytes of information. This is the total amount of storage that is normally available on the computer for a teacher to use. When a teacher asks for work space on the computer, the normal assignment is two segments of 30 kilobytes. More space can be requested and must be justified to the APL staff person.

The computer access time, internally, is eight microseconds. This is true for all types of work whether it is remote or batch. Since APL is a time sharing system, it is continually using this access time and returns results to APL users faster than any batch user can get results.

The computer languages that the administrator feels that the teachers know are APL and FORTRAN with APL being the main one. The languages that are available for teachers to use include FORTRAN, APL, COBOL, BAL, and PL/I.

There are 150 programs in the public library for teachers to use and there are also 150 programs in the teacher library (produced by teachers) for teachers to use. Normally, only 150 of these programs are available for a teacher to use. This is due to the fact that it is necessary to change the disc being used for APL in the computer room in order to change to the other set of programs.

Only APL programs can be made available for a teacher to use for class. A teacher can write a program completely using APL in two to three days and have it ready for class use. If a teacher finds a program that is already written and simply gives it to someone to transfer from tape to the APL system, they must wait overnight for it to be available for class use. If it has to be typed into the system, it could be ready, and generally is, the same day.

There is no budgeted amount allocated for the use of the computer as an instructional medium. Instructional use of APL requires 42 kilobytes of the computer plus a prorated share for each person who signs onto the APL system. This is used from 7:30 to 4:30 each day. The average amount of storage used by APL on the computer is about 100

kilobytes. Both APL and the computer science courses together use about 25% of the total computer resources.

The computer utilization at Shawnee Mission is 70% administrative and 30% instructional. This excludes things like grade reporting, the library system, and class scheduling from instruction. However, only 15% is used for payroll processing, finance and other business transactions while 85% is used for other administration and instruction.

There was no question in the interview that the administrator noted that seemed exceptionally good. The question that was noted that seemed exceptionally poor asked about the difference in internal timing of the computer for different types of jobs being executed. Questions that were expected included those that would determine the administrator's feelings about community, student, and teacher attitudes. He did not feel that any questions needed to be added to the interview, however.

Totals for Teacher Interview

There were 36 teachers who said they used the computer as an instructional aid and 15 who said that they did not. There were 36 also who said they currently desired to use the computer as an instructional aid and only 11 who did not. Of the 15 who said that they did not use the computer, 12 said that they would like to use it if they were given appropriate circumstances while the other 3 did not.

The average number of class periods taught by the teachers interviewed was 4.74. The average number of students in all of their classes per day was 126.76. The subjects taught included: mathematics, science, humanities, business, and social studies. The subjects that teachers used the computer to support included all of these subjects. However,

certain specific courses were not included such as English on the Job, basic math, and record keeping.

The average amount of time per month that teachers who used the computer spent using the computer in preparing materials for instruction was 6.95 hours. They used the computer in an average of 3.25 of their classes. They used 18.05 hours of classroom time per month presenting materials that were stored on the computer for classroom use.

There were 13 teachers who felt that they received released time for the development of instruction. Generally the released time was their planning period. The remainder did not consider their planning period to be released time. There were three teachers who used their planning period for preparation of materials that use the computer as an instructional medium. There were 30 computer users who said that they had not ever been given released time for the development of instruction while four said that they had. There were 30 teachers who felt that released time would be necessary in order for them to develop instruction that uses the computer as an instructional medium while 18 did not feel that released time would be needed. Most teachers commented that it would be helpful and a few teachers felt that it was not necessary.

There was an average of 48.82 students using the computer as an instructional medium in the computer users' classes. The average student works 5.13 hours per month on the computer for these classes. All of the students in these classes work on the computer an average of 82.40 hours per month. The teachers suggested or assigned an average of 8.66 different existing computer programs for their students per month.

There were 24 teachers who had written programs for students and they had written an average of 18.59 programs to be used by students. There were 19 who felt that their programs could be characterized as having an interaction style. Of these, 10 felt that their computer program interaction style was open-ended, five felt that it was closed and four were midway. Also, ten felt that their computer program interaction style was a flexible presentation, six felt that it was a strict flow and three were midway. There were seven who placed their computer programs in friendly conversation and eight who placed them in formal presentation while four were midway. However, there were 13 who felt that they were student-oriented while three felt that they were presenter-oriented and three were midway.

The interaction style for the teachers in general paralleled the trends indicated for the computer program interaction style with more emphasis on midway. There were 29 who characterized their interaction style with students in normal classroom activities as open-ended, eight who characterized it as closed and 13 who were midway. There were 32 who felt that it was a flexible presentation, six who felt that it was strict flow, and 12 who were midway. There were 26 who felt that it was a friendly conversation while 10 were formal presentation and 14 were midway. However, there were 21 who felt their interaction style was student-oriented while 13 were presenter-oriented and 16 were midway.

The average percentage of the classroom use of the computer that was as the object (learning about the computer) of instruction was 16.07% while the average for the means (learning through the computer) was 60.66%. Many types of instructional programs were used on the

computer. There were 25 who used the computer in a problem solving mode for students, 23 who used the simulation and games mode, 19 who used it in the student programming mode, 16 who used it for managing instruction, 15 for a problem generator, 14 for dialog, 13 for diagnostic and testing, 12 in the tutorial mode, and 11 for inquiry and for drill and practice.

The average percentage of the programs that teachers wrote for the computer that presented materials only was 23.67%. The percentage that reacted to student input was 61.04%. The percentage that adapted using student history as well as responses was 54.18%.

Most of the programs that teachers had in mind but had not yet written were enhancements of the present materials. There was also a general emphasis on simulations and games. A few wanted some management programs to assist teachers. There were many others mentioned by a few teachers. The main thing that teachers felt would help them write these programs was released time. Other things included hardware additions and additional training. The average number of computer programs that teachers knew were available for their use was 42.83.

There were 32 teachers who knew a computer language. The languages they knew included BASIC (22), FORTRAN (16), and APL (10). The languages COBOL, ASSEMBLER, PL/I, CMS, WIPLE, SPS, and ALGOL were also included with one or two knowing any of them. The languages that teachers used to write programs were BASIC (22), APL (8), and FORTRAN (4). The average amount of time that teachers had been programming with BASIC was 7.07 years while FORTRAN was 5.52 years and APL was 3.57 years. The average number of programs that teachers had written with APL was 101.11 while FORTRAN was 96.75 and BASIC was 60.76.

The next section deals with the teacher's perceptions of the awareness of various groups in terms of the use of the computer as an instructional medium. The average awareness for the portion of the community that was aware was 19.87% and their attitude was perceived as generally positive (21), with very positive and neutral at 15 which averages positive. The average awareness for the portion of the administration that is aware was 79.20%. They were likewise positive (28) but tended toward very positive (13) rather than neutral (10). The average awareness for the other teachers was 54.03% and they were heavily positive (32) with a tendency toward neutral (13) rather than very positive (4) or negative (1). The average awareness for the staff was 52.27% and they tended to be positive (23) or neutral (17) rather than very positive (4) or negative (2). The average for the portion of the students who were aware was 43.46%. They were generally positive (26) with very positive (13) and neutral (12) averaging to positive.

There were 37 teachers who felt that there was a possibility for recognition as a result of using the computer and 14 who felt that there was not any. A tendency to separate teachers and students arose in the answers to this question. The possibilities included ego-building, publicity and awards, and pioneering. There were some negative recognition possibilities also such as more work and "it shouldn't be expected."

For teachers who were not using the computer, the main things that they felt would enable them to use the computer in instruction were: additional training, more equipment, and having course materials on the computer. Other factors were additional time, assistance, and money.

The teachers felt that the computer could have a beneficial educational impact. The ways in which this could occur include individualization of materials, shift in teacher activities (change in teacher role), and motivation. There was also some emphasis on the fact that the computer is a tool and the improved understanding that the student will have of the computer in the world.

Most of the teachers said that if they were given anything they needed in terms of time, money, and equipment in order to use the computer as an instructional aid they would purchase more equipment. Other ideas generally dealt with expansion of the classroom related materials including simulations, games, problems, diagnostic programs, tests, and student designed programs. Other notable ideas include "to learn about using the computer," "systematic analysis of subject matter for computer presentation," "released time for teacher to prepare materials," and "workshops about the use of the computer for instruction."

In the next section, the teachers were asked questions which would determine which questions they thought were best and which ones they felt were poorest as well as what they thought could be done to improve the interview. There were 36 teachers who noted one question as seeming exceptionally good while 14 did not. The main questions that were noted included the open-ended question (no. 56) concerning the use that the teacher would make of the computer as an instructional aid if they were given anything they needed for support. They also pointed to the question concerning the educational impact (no. 55) as being good. Their comments indicated that these questions had caused them to think of new possibilities as the reason that they noted them. Some teachers noted that the questions concerning released time (nos. 11-14) indicated

an area of concern. Others felt that the student awareness questions (nos. 50, 51) were good.

The main questions that the teachers noted that seemed exceptionally poor were those concerning interaction style (nos. 20-27) and those concerning attitudes of others (nos. 42-51). There were some complaints about the terminology. These concerned the use of the computer terms and "educationeze." Other comments dealt with the perceived vagueness of the interview and its repetitive nature.

There were 14 teachers who had expected questions that were not included. Some had expected more specific questions about what they were actually doing with the computer in instruction. Others had expected questions about their own attitude toward the use of the computer in instruction. Still others had expected to be asked questions that would evaluate the current use of the computer in the schools.

There were 19 teachers who felt that there were questions that needed to be added to the interview. Questions that should be added included questions that dealt with evaluation techniques of teachers, questions about student learning compared to non-computer techniques, motivation for continuing use of the computer for instruction, and economic questions for the teacher. Additional questions included specific uses, how to get information about using the computer, impact on classroom behavior, and specific problems of computer users.

CHAPTER V

IMPROVED PARADIGM

There are essentially two things that this research is intended to produce. One is a paradigm that helps in understanding the factors that affect the use of the computer as an instructional medium. The second is a questionnaire that can be used to determine whether or not the teachers in a school system are likely to use the computer for instructional support.

Updating the paradigm will require an analysis of the original paradigm both through analysis of the interviews and Gestalts of the paradigm. The last few questions of the interview encouraged the subjects to suggest ways in which the interview could be improved. These will supply additional information for updating.

In developing the questionnaire, it is important to select those components from the paradigm that reveal the teachers are likely to use the computer in instruction. In doing so, it is necessary to discover what factors indicate that the computer will be used. This means that the teachers should feel that the computer provides an excellent means for presenting materials to students in a variety of student settings and cognitive styles.

The questionnaire is a pragmatic instrument for the purpose of detecting whether or not individual teachers would use the computer for instructional support. The factors indicating that a teacher has a

strong desire to provide the best possible materials to the students and that the teacher is willing to use any means that does this best are not covered here. These factors might have importance in terms of teacher quality, but they are not of value for determining whether they are likely to use the computer in instruction.

The teachers need to feel that the computer is an excellent means of presenting information and materials. They should feel that it provides a broad spectrum of the desired presentation styles and that it is the best means for presenting materials in these styles.

Interview Results

Wichita Case Study Summary

Basically, all of the teachers interviewed (32) expressed a desire to use the computer in support of instruction. One teacher expressed concern that some teachers had learned to use the computer and had not been allowed to use it.

Most of the teachers were teaching five classes per day with about 25 students per class. Most of those interviewed were teaching mathematics or science, but most subjects were represented. The computer was used mostly in mathematics, but again most subjects were represented.

Those who used the computer used it in half their classes. They spent a little over five hours per month using the computer in preparing instructional materials and about half that amount of classroom time in presenting materials that had been stored on the computer for classroom use.

Most teachers were given a one-hour planning period each day. There was no released time given except for department chairmen who generally got an additional hour per day. About one-third of the teachers felt that the planning period was actually released time. There were no provisions for special released time in order to use the computer in instruction. Workshops for learning about the use of the computer were given in the summer and were supported by NSF grants. About one-third of the teachers did not feel that released time was necessary in order to use the computer in instruction.

About one-fifth of the students in the computer users' classes were using the computer as an instructional medium. They averaged about six hours per month of computer time each. However, the average total per month was about 84 hours rather than the 300 indicated by the number of students and the average time per student. Teachers suggested that students use about 12 different programs per month.

Teachers who used the computer felt that the interaction style of their programs was open-ended, flexible, friendly, and student-oriented. However, teachers in general were split concerning their own interaction style. There was an emphasis on open-ended and flexible, but formal presentation and presenter-oriented were larger than for computer users while the midway position made considerable gain.

There was very little classroom time spent learning about the computer. Most of the use of the computer was as a tool of learning. Most of the programs were problem solving, simulation and games, and student programming. Programs that teachers had written emphasized reaction to student input with little that presented material only and nearly none that adapted using student history.

Most of the programs that teachers wanted to write enhanced present materials or were simulations. The main thing they needed in order to write them was time. Most teachers felt that they had about 50 programs available for their use and the teachers who had written programs had written about 15 programs for their students to use.

The main computer language that teachers knew was BASIC. A few knew FORTRAN as well. However, BASIC was the language they used for writing programs for the computer. They had known BASIC for about seven and one-half years and had written about 70 programs with BASIC.

Teachers generally felt that the attitude of others toward the use of the computer in instruction was positive although one felt that teachers and staff were negative. They felt that about 15 percent of the community, 80 percent of the administration, 50 percent of the faculty and staff, and 40 percent of the students were aware of the computer as an instructional medium.

Generally, teachers felt that recognition was possible as a result of using the computer, but there was also a strong tendency to feel that someone else would receive the recognition. Many teachers pointed out publicity that others had received or that students had achieved or could try for.

The teachers who were not using the computer felt that training or additional equipment would be necessary before they could use it.

All of the teachers felt that the educational impact that the computer could have was considerable. The main impact, however, was that students would understand the computer. Other impact possibilities included individualization and motivation. The specific impact for Wichita was that students learn through teaching the computer.

The main thing that teachers would do with unlimited resources was buy more equipment and materials. However, some would make the computer more available to students and others would learn more about using the computer.

The teacher evaluation of the interview indicated that they preferred the open-ended questions that encouraged them to think of possibilities. The questions they did not like were those that they had difficulty understanding, especially the ones about interaction and those about attitudes of others.

There was a great deal of variety in the questions that were expected although most teachers had not expected any specific questions. Most of these questions dealt with value of the computer experience to the student or attitudes of the teacher being interviewed about the computer. Less than half of the teachers felt that questions needed to be added. The questions that teachers felt needed to be added dealt with student learning and teacher motivation to make more use of the computer.

Shawnee Mission Case Study Summary

There was one teacher in the interview sample (19) who did not want to use the computer in support of instruction. There were only four who had not used the computer in support of instruction.

Most of the teachers were teaching five classes per day with about 26 students per class. Most of the teachers interviewed were teaching either mathematics or science although there was a good cross section of all types of teachers. The computer was being used in most subjects with business classes being poorly represented.

Teachers used the computer in most of their classes, if they used it at all. They spent almost nine hours per month using the computer in preparing materials for instruction and almost 40 hours per month presenting these materials in their classroom.

Most teachers were given a one hour planning period each day. There was no released time given. About one-seventh of the teachers felt that the planning period was actually released time. One teacher used part of the planning period for developing instruction on the computer. Workshops were held during the summer for learning about using the computer and for developing materials for the computer. Half of the teachers felt that released time would be necessary in order for them to use the computer in instruction.

About one-third of the students in the computer users' classes were using the computer as an instructional medium. They averaged about three hours per month of computer time each. However, the average total per month was about 80 hours rather than the 135 hours implied by the number of students and the hours each student spent on the computer. The teachers suggested that students use about three and one-half different computer programs per month.

The teachers who used the computer felt that the interaction style of their computer programs was closed, strict flow, formal, and student-oriented. The teachers felt that their own interaction style was open-ended, flexible, friendly, and student-oriented.

Less than 20% of the use of the computer in the classroom was spent in learning about the computer. Over 60% of the use of the computer was as a tool. Most of the use of the computer was in diagnostic and testing. But problem solving and managing instruction

were almost as frequent and simulation and games, and problem generation were nearly as frequent. The programs that teachers had written mainly reacted to student input while about half as many presented information only. Over 10% used student history as well as responses to adapt.

Most of the programs that teachers wanted to write were extensions of programs that were already started or were simulations and games. Management processes also were frequently mentioned. The main thing that would encourage them to write these programs was released time or additional equipment. Most teachers felt that they had about 30 computer programs available for their use, while the teachers who had written programs had written about 17 programs for their students to use.

The main computer language that teachers knew was APL. Almost as many could use FORTRAN. However, APL was the language they used for writing programs for the computer. They had known APL about three and one-half years and had written about 100 programs with APL.

Teachers generally felt that the attitude of others toward the use of the computer in instruction was positive although one felt that the staff was negative about it. There was a strong tendency toward neutral. They felt that almost 30% of the community, about 80% of the administration, almost 60% of the teachers and staff, and almost 50% of the students were aware of the use of the computer as an instructional medium.

Generally, teachers felt that recognition was possible as a result of using the computer, but there was a strong tendency to feel that someone else would receive the recognition.

The teachers who were not using the computer felt that learning about the computer and having their class materials stored on the computer would be necessary before they could use it.

The main educational impact that the computer could have was beneficial. The main ways mentioned were motivation, individualization, and change of the teacher role.

The main thing that teachers would do with unlimited resources was buy more equipment and materials.

The teacher evaluation of the interview indicated that they preferred the open-ended questions which encouraged them to think of possibilities. The questions that they felt were poor were those which had difficult vocabulary. These included the interaction style questions and the attitude questions. Some felt that certain groups of questions were too repetitious.

About one-fourth of the teachers had expected questions that were not included and suggested that questions be added. The main questions that they had expected were specifics about how they actually used the computer and their personal attitudes about the use of the computer in instruction. The questions they wanted added concerned detection of problems that exist.

Summary

It seemed that users of the computer for instructional purposes would distinguish themselves through their answers to the first three questions on the interviews. However, there were few who actually answered that they were not using the computer (Table II). This is partially because the sample emphasized users. However, even those

TABLE II

SUMMARY OF SELECTED INTERVIEW RESPONSES

	W	WN	S	SN	A	AN	
Amount using computer(1)	65.6	-	78.2	-	70.6	-	%
Desire to use it (2)	75	-	84.2	-	76.6	-	%
Nonusers desire (3)	81.8	-	75	-	80	-	%
Classes taught (4)	4.74	4.5	4.74	4.25	4.74	4.44	/day
Students taught (5)	126	130	129	100	127	123	/day
Preparation on computer (8)	5.35	-	8.9	-	6.9	-	hours/ month
Classes on computer (9)	2.56	-	4.14	-	3.2	-	/day
Class presentation (10)	2.66	-	37	-	18.1	-	hours
Release time (11)	34.5	35.4	16.7	-	27.7	53.3	%
Computer release (12)	0	-	6.7	-	3.3	-	%
Ever release (13)	10.5	-	13.3	-	11.8	-	%
Need Release (14)	70	16.7	50	50	62.5	75	%
Students using (15)	51.5	-	46.1	-	48.8	-	
Students use (16)	6.2	-	3.3	-	5.1	-	hours/ student/ month
Students use (17)	83.8	-	79.5	-	82.4	-	hours/ month
Programs assigned (18)	12.3	-	3.45	-	8.7	-	
Programs written (19)	14.9	-	17.3	-	15.9	-	
Computer as object (28)	15.1	-	17.2	-	16.1	-	%
Computer as means (29)	60.4	-	61.1	-	60.7	-	%
Present only (31)	20.9	-	27.5	-	23.7	-	%
React as well (32)	63.6	-	57.5	-	61.0	-	%
Use history as well (33)	1.9	-	11.7	-	5.9	-	%
Programs in mind (34)	59.4	25	52.6	0	56.9	18.7	
Programs available (37)	51.0	0	29.7	0	42.8	1.0	
Recognition (52)	71.9	75.0	73.5	50	72.5	68.7	%

The numbers represent averages for the questions. The question number on the teacher interview is in parenthesis (see Appendix I).

who were expected to answer "no" generally answered "yes" to the third question.

The real separation in teacher use of the computer arose in those questions that asked about writing computer materials. Here most of the users said that they did not write materials for the computer even though they use the computer for instruction. Apparently most teachers in Wichita and Shawnee Mission use materials produced by someone else.

Analysis of the first three questions also indicated that more teachers wanted to use the computer than were using it. In fact, a higher percentage of the teachers who were not using the computer desired to use it than of those who were. This could be interpreted also to mean that Shawnee Mission had more resources available than the teachers were using while Wichita had less than the teachers would like to use.

The nonusers did not have as many classes as did the users; they taught 4.4 classes per day versus 4.7 for the users (Table II). This was apparently caused by the fact that some of the nonusers were supervisors and one was a vocational teacher and therefore had a limited teaching load (three classes of 20). The Wichita nonusers taught more than the average number of students while the Shawnee Mission nonusers taught less. Again, this smaller number may be explained by the supervisory and vocational roles of the teachers.

The concepts in these two questions determine the level of activity that the teacher has in the classroom. This means that the questions are useful in terms of determining how many of the teachers' students and classes would be using the computer.

The next two questions (Table II) determine what subjects the

computer is used with and what subjects the teachers were teaching. These revealed that all subjects were covered and that all subjects were represented on the computer although certain specific classes were not. Some teachers expressed the attitude that the computer was appropriate for subjects other than those that they taught.

The fact that some teachers felt that the computer was more appropriate for subjects other than those they taught could be useful in detecting whether a teacher would actually use the computer in subjects that the teacher was teaching.

The computer was used for instruction in the following ways (see Table II). The preparation of materials for class averaged about seven hours per month with the Shawnee Mission teachers spending over five hours per month. The number of classes in which the computer was used was over four in Shawnee Mission with Wichita teachers using the computer in an average of 2.6 classes. Users in Shawnee Mission spent an average of 37 hours presenting materials that had been stored on the computer for classroom use while Wichita teachers spent 2.7 hours. However, most of the use in Shawnee Mission is not on the computer terminal; the materials are generated before class time and copies of the materials are used in the classroom. If the values that are more than 50 hours per month are removed the average reduces to four hours per month while removing those that are over 100 hours reduces the average to 8.2.

The above type of information would indicate whether a teacher was likely to actually use the computer. They could be asked in terms of the number of students as well as the amount of time that the teacher would actually use the computer with students.

There were few teachers who felt that they received released time for instructional development (see Table II). The highest number were the Wichita teachers who did not use the computer. There were 36% who said that they received released time while Shawnee Mission nonusers felt that none was given. One teacher said that the released time could be used for computer development while all others said that none was given for that purpose. Most of the teachers (88%) felt that they had not ever been given released time for development of instruction using the computer. However, only 50% of the teachers in Shawnee Mission felt that released time was needed in order to use the computer for instruction. In addition, Wichita teachers felt that released time was necessary (70%) while 83% of the Wichita nonusers felt that it was not.

Questions concerning the need for released time and the amount of assistance that would be needed in order to use the computer would help in determining what blocks might arise if the computer were made available with no other support.

In spite of the heavy use of the computer for instructional support in Shawnee Mission (see Table II), they have fewer students who are using the computer as an instructional medium (average is 46) than do Wichita teachers (51). Likewise, the average student in Shawnee Mission only spends 3.3 hours per month on the computer while the average student in Wichita spends 6.2 hours. The higher number in Wichita is due in part to the fact that most of the computer use is for student programming. From these two figures, it seems that the amount of time spent using the computer for students in Shawnee Mission should be about 152 hours while Wichita should be about 316 hours. However,

Shawnee Mission teachers said that the total amount of time that their students used the computer was almost 80 hours while the Wichita teachers said their students used the computer almost 84 hours per month. These imply that either the hours should be 1.74 in Shawnee Mission and 1.65 in Wichita, or the number of students should be 24.2 in Shawnee Mission and 13.5 in Wichita. These figures imply that there was some misunderstanding about what the questions meant.

Since the numbers seem to be inflated when the number of students and time per student is used to find the amount that the computer would be used, it seems that the hours per month question would find a conservative estimate of computer use.

The number of computer programs that teachers assign their students is about 12 in Wichita and about 3.5 in Shawnee Mission (Table II). This is mainly due to the fact that the Shawnee Mission students do not directly use the computer, in general. They use computer generated materials instead. The number of computer programs that teachers have written for students is about 17 in Shawnee Mission and about 15 in Wichita.

The possibility that teachers will be motivated to write computer programs for their students to use needs to be detected. A question in this category would provide that possibility.

The next four questions deal with the interaction style that the computer programs written by the teachers have with students (see Table III). The components of interaction style are treated as items on a continuum with the first item in the question being graded 1, midway graded at 2, and the second being graded at 3. The Wichita teachers were strongly to the open-ended side of the continuum with 1.3 while

TABLE III

INTERACTION STYLE

	Computer			Personal						
	W	S	A	W	WN	S	SN	A	AN	AT
Open	1.3	2.22	1.76	1.68	1.83	1.42	1.5	1.55	1.66	1.61
Friendly	1.7	2.44	2.07	1.84	1.75	1.42	1.25	1.63	1.5	1.56
Flexible	1.2	2.44	1.82	1.48	1.5	1.5	1.48	1.49	1.48	1.49
Student	1.4	1.56	1.48	2.03	2.17	1.53	1.75	1.78	1.96	1.87
Average	1.4	2.16	1.78	1.76	1.81	1.47	1.49	1.61	1.65	1.63

The continua that were used were graded from 1 for the above titles, with 2 for midway, and 3 for the opposites. The above table gives the averages. Thus the overall average, AT, was a little more than halfway between the open, friendly, flexible side and midway.

the Shawnee Mission teachers were toward the closed end with 2.2. The presentation style ranged from flexible to strict flow and Wichita was at 1.2 while Shawnee Mission was toward the formal end with 2.4. However, both were on the student-oriented end of the student-presenter-oriented continuum with Wichita at 1.4 and Shawnee Mission at 1.6. The averages show that Shawnee Mission teachers who use the computer are more formal than are the Wichita teachers who use the computer. However, the teachers generally had a tendency to be student-oriented.

The following four questions turned to the teacher's own personal interaction style, but with parallel continua (see Table III). On the open-ended to closed continuum Shawnee Mission teachers were closer to open-ended with 1.4 for all teachers and 1.5 for nonusers while Wichita was still below midway with 1.7 for teachers and 1.8 for nonusers. All teachers were 1.5 on the flexible presentation to strict flow continuum. Again, Shawnee Mission was closer to the friendly conversation end of the friendly conversation to formal presentation continuum with 1.4 for all teachers and 1.2 for nonusers while Wichita was at 1.8 for all teachers and 1.7 for nonusers. All teachers moved toward the presenter-oriented end of the student- to presenter-oriented continuum with 1.7 for Shawnee Mission nonusers, 1.5 for Shawnee Mission teachers, 2.0 for Wichita overall, and 2.2 for Wichita nonusers. The average showed that all teachers versus nonusers were close to the same, overall. However, nonusers were considerably more toward the presenter-oriented end of the continuum than the teachers as a group were.

The mixed findings in these questions imply that they will not make much contribution to the determination of the likelihood that the computer will be used in instruction.

The percentage of computer use in the classroom as the subject of instruction was low with a 15% average in Wichita and a 17% average in Shawnee Mission (Table II, page 136). Most of the Shawnee Mission average was from the computer science courses. The percentage of computer use as a means for instruction was considerably higher with over 60% in both systems.

Again, there was little distinction here so that a question to distinguish between use of the computer as an object or as a means of instruction does not seem useful in the questionnaire.

The types of instructional programs that are used are presented in Table IV according to the percentage of the responses for each system. In Wichita they start with problem solving at 19%, simulation and games at 18%, and student programming with 16% of the Wichita program types. The remainder of the types of instructional programs were fairly evenly distributed although diagnostic and testing was obviously at the bottom with 3%. The program types for Shawnee Mission were not separated so widely so that diagnostic and testing had 13%, problem solving had 12%, managing instruction had 12%, simulation and games had 11%, problem generation had 11%, and dialog had 10%. Inquiry was at the bottom, but not as clearly, with 6%.

The categories problem solving, and simulation and games were high for both. However, Shawnee Mission showed a tendency toward management type programs and Wichita showed a marked tendency toward student programming. These are in fact their priorities for computer use in instruction. It is interesting that drill and practice which has been one of the major emphases in research for the computer is so low for both and that inquiry (an instructional emphasis) is also low for both.

TABLE IV

INSTRUCTIONAL PROGRAM TYPES (NO. 30)

	W	S	A
Problem solving	19.5	12.2	15.7
Simulation and games	18.2	11.0	14.5
Student programming	15.6	8.5	11.9
Managing instruction	7.8	12.2	10.1
Problem generator	7.8	11.0	9.4
Dialog	7.8	9.8	8.8
Diagnostic and testing	2.6	13.4	8.2
Tutorial	7.8	7.4	7.5
Drill and practice	5.2	8.5	6.9
Inquiry	7.8	6.1	6.9
Total	100	100	100

These data are by percentages of the total for each school system.

Since the tendency to use a type of instructional program gives an idea of the amount of computer use, questions of this type will be used in the questionnaire.

The program types with respect to the student interaction are basically those that present material only, those that react to student input, and those that adapt using student history as well as responses. The programs written by the teachers were low in the category where adaptation uses student history; 2% in Wichita and 12% in Shawnee Mission (Table II, page 136). This higher figure in Shawnee Mission was probably because the teachers interpreted the interaction of the presentation of the computer generated materials as belonging in this category. They were also low in the category of programs that present materials only with 21% for Wichita and 27% for Shawnee Mission. Both were high in the category that reacts to student input with 64% in Wichita and 57% in Shawnee Mission.

These items again did not show any distinction among types, so questions to distinguish among program interaction types will not contribute to the questionnaire.

Over half of the teachers had programs in mind that were not yet implemented on the computer for instruction (see Table II, page 136). In Shawnee Mission, almost 53% did while over 59% in Wichita did. However, nonusers had very few programs in mind; those in Shawnee Mission had none while 25% of those in Wichita did. The awareness of programs available was about the same in Wichita with 51% while Shawnee Mission was only 30% overall. However, the nonusers knew of very few.

Since these questions were so strongly different between the users and the nonusers, they will contribute to the questionnaire.

Most of the languages known were BASIC, APL, and FORTRAN. Others were represented, but at a very low level. Therefore the analysis will treat only these three (Table V). The computer language used for instruction in Wichita is BASIC while APL is used in Shawnee Mission. More Wichita teachers knew BASIC (71%) than Shawnee Mission teachers knew APL (55%). This is due to the fact that the language itself is not used for instruction in Shawnee Mission while the language is taught as part of the Algebra course in Wichita. However, no Wichita teachers knew APL while 11% of the Shawnee Mission teachers knew BASIC. This may be explained by the fact that BASIC is more generally available. The nonusers in Shawnee Mission did not know any computer language other than APL while the Wichita nonusing teachers were split between BASIC and FORTRAN with BASIC being 80% of the languages known by Wichita nonusers.

The languages that the teachers used (Table VI) show the same trend with BASIC being used by 95% of the Wichita teachers and APL being used by 80% of the Shawnee Mission teachers. FORTRAN was used by 5% of the Wichita teachers while it was used by 20% of the Shawnee Mission teachers. Here again, the computer science teachers in Shawnee Mission caused this deviation.

In spite of the fact that BASIC was known considerably longer (Table VII) (7.5 years in Wichita) than APL (3.6 years in Shawnee Mission) the average number of programs written (Table VIII) with BASIC was 67 while the average for APL was 101. FORTRAN had been known an average of 6 years in Wichita and 4.5 years in Shawnee Mission. FORTRAN had been used to write an average of 116 programs in Wichita and 70 in Shawnee Mission. Four of the nonusing teachers in

TABLE V

AMOUNT (NO. 38)

	W	WN	S	SN	A	AN
BASIC	51.0	80.0	11.1	0.0	45.8	66.7
APL	0.0	0.0	55.5	100.0	20.8	16.7
FORTRAN	29.0	20.0	33.3	0.0	33.3	16.7

The number of teachers that know these computer languages is given according to the percentage of the total for each category.

TABLE VI

USUAGE (NO. 39)

	W	S	A
BASIC	95.4	0.0	64.2
APL	0.0	80.0	23.9
FORTRAN	4.5	20.0	11.9

The usage of the above languages in programs for student learning is given by percentage of total usage for each category.

TABLE VII

YEARS OF PROGRAMMING (NO. 40)

	W	WN	S	SN	A	AN
BASIC	7.5	1.3	5.0	0.0	7.1	1.3
APL	0.0	0.0	3.6	2.0	3.6	2.0
FORTRAN	6.3	0.0	4.5	0.0	5.5	0.0

The average of the number of years that those who actually program have been programming.

TABLE VIII

PROGRAMS WRITTEN (NO. 41)

	W	WN	S	SN	A	AN
BASIC	67.1	25.0	7.2	0.0	60.8	25.0
APL	0.0	0.0	101.0	1.0	101.0	1.0
FORTRAN	116.0	0.0	70.2	0.0	96.7	0.0

The average number of computer programs written with the languages.

Wichita knew BASIC and had written an average of 25 programs out of an average of 1.3 years of experience. One of the nonusing Shawnee Mission teachers knew APL for about two years and had written one program. Two of the Shawnee Mission teachers knew BASIC and had written an average of 7.2 programs out of an average of five years of experience.

These figures make more sense when one examines the number of grams written per year (Table IX) for each language. Thus, almost nine programs per year were written using BASIC in Wichita versus 19 per year for the nonusers in Wichita and 1.4 per year for all Shawnee Mission teachers. This turns out to be 8.6 programs per year for all teachers versus 19 for nonusers. With APL, Wichita teachers still show no programs while the Shawnee Mission teachers show that 28 were written per year and their nonusers 0.5 per year. Nonusers did not write programs in FORTRAN while Wichita teachers wrote 18 programs per year using it, and Shawnee Mission teachers wrote 16 programs per year for an overall average of 18.

Thus APL programmers appear to be more prolific than other programmers while BASIC programmers seem to be the least prolific. These questions did not reveal any results that indicate that the teacher might have more desire than the average teacher to use the computer.

The next series of questions deal with the level of awareness (Table X) and attitude (Table XI) that the teacher feels that significant others for the teacher possess. The teachers felt an average of 19% of the community was aware of the use of the computer as an instructional medium. They felt that 84% of the administration, 55% of the teachers, 53% of the staff, and 44% of the students had this awareness. The Shawnee Mission teachers generally felt that their constituency was more

TABLE IX

PROGRAMS WRITTEN PER YEAR

	W	WN	S	SN	A	AN
BASIC	8.9	19.2	1.4	0.0	8.6	19.2
APL	0.0	0.0	28.1	0.5	28.1	0.5
FORTRAN	18.4	0.0	15.6	0.0	17.6	0.0

The number of programs written per year as calculated from the averages in Table VII and Table VIII.

TABLE X

AWARENESS

	W	WN	S	SN	A	AN	AT
Admin.	79.6	70.2	78.5	98.7	79.0	84.4	81.7
Teachers	50.7	48.7	59.6	82.5	55.1	65.6	60.4
Staff	48.7	45.4	57.6	82.5	53.1	63.9	58.5
Students	41.0	23.3	47.5	47.5	44.2	35.4	39.8
Community	14.3	13.2	27.8	20.2	21.0	16.7	18.9
Average	46.9	40.2	54.2	66.3	50.5	53.2	51.9

Awareness of use of the computer as an instructional medium. The above are averages of the percentages that teachers felt that their constituency were aware of the computer as an instructional medium.

TABLE XI

ATTITUDE

	W	WN	S	SN	A	AN	AT
Admin.	3.94	3.92	4.26	4.5	4.10	4.21	4.15
Teachers	3.72	3.83	3.89	4.0	3.80	3.91	3.86
Staff	3.61	3.45	3.67	4.0	3.64	3.72	3.68
Students	4.06	3.83	3.95	3.75	4.0	3.79	3.90
Community	3.97	3.67	4.05	3.25	4.01	3.46	3.73
Average	3.86	3.74	3.96	3.90	3.91	3.82	3.86

Attitude that teachers felt that their constituency has toward the use of the computer as an instructional medium. The numbers are the averages of the attitude given by the teacher on a scale that runs from very negative being 1 to very positive being 5 with 3 being neutral.

aware. The awareness according to the Shawnee Mission nonusers was even higher while the Wichita nonusers felt it to be lower. The Shawnee Mission teachers felt that the awareness level of the community was about 28% while their nonusers felt that it was about 20% and the Wichita teachers placed it at 14% while the Wichita nonusers placed it at 13%. The Shawnee Mission nonusers felt that their administration awareness was very high at 99% while the Wichita teachers were next with 80% with Shawnee Mission teachers at 78% and Wichita nonusers at 70%. Again, the Shawnee Mission nonusers were high for teacher awareness at 82% but Shawnee Mission teachers were at nearly 60%, Wichita teachers were at 51%, and Wichita nonusers were at 49%. Likewise for staff awareness, Shawnee Mission nonusers were high with 82% while Shawnee Mission teachers had about 58% with Wichita teachers at about 49% and Wichita nonusers at 45%. Finally, student awareness was placed at 47% by both Shawnee Mission teachers and nonusers while Wichita teachers were at 41% and Wichita nonusers were at 23%.

The scale that was used for the attitude ran from very positive, which was assigned a numerical value of five, down to very negative, which is one, with positive, neutral and negative between. The teachers felt that the community was positive toward the use of the computer as an instructional medium. They felt that the administration was a little higher than positive with 4.10, students at 4.0, teachers were lower than positive with 3.80, and the staff was even lower with 3.64. The Shawnee Mission teachers were high since their community was felt to be above positive with 4.05 while Wichita teachers were next with their teachers at 3.97 and Wichita nonusers at 3.67 while Shawnee Mission nonusers were at 3.25. The next three categories parallel the findings of the

preceeding paragraph in which the Shawnee Mission nonusers were high, their teachers next, Wichita teachers next, and their nonusers at the bottom. Thus, the administration attitude was 4.5 for Shawnee Mission nonusers, 4.26 for their teachers, 3.94 for Wichita teachers and 3.92 for their nonusers. Teacher attitudes were rated at 4.0 for Shawnee Mission nonusers and 3.89 for their teachers. Wichita reversed for this category with nonusers at 3.83 and their teachers at 3.72. The staff attitudes were rated at 4.0 for Shawnee Mission nonusers, 3.67 for their teachers, 3.61 for Wichita teachers, and 3.45 for their nonusers. The student attitude showed a different order in which Wichita teachers were high with 4.06, Shawnee Mission teachers were at 3.95, Wichita nonusers were at 3.83, and Shawnee Mission nonusers were low with 3.75.

The small range of attitudes is noteworthy. All of these teachers generally felt that all their constituency were positive toward the use of the computer for instruction. There were three negative tallies for the entire group interviewed and these were with respect to either teachers or staff. The lowest attitude average was 3.45 while the highest was 4.5 so that the attitude range was from below positive to well above positive. The range of awareness was considerably larger since it ran from 13.2% to 98.7%.

In addition to the ordering of the teacher responses which is difficult to explain, i.e. the feeling of the nonusers of Shawnee Mission that their constituents are most aware with the Shawnee Mission teachers next, Wichita teachers next, and the Wichita nonusers last; another relationship needs to be noted. This second relationship is considerably easier to explain. Here the groups who are rated highest are the

administration followed by the teachers, staff, students, and then community in that order. This can be explained by the closeness that the group has to the overall picture in terms of the educational process as perceived by the teacher. The high attitude for students in Wichita can be attributed to the fact that the students who use the computer have selected to use it and therefore reveal a desire that students without choice would not reveal.

These questions seem to contribute considerably to the knowledge of how the teachers perceive their constituency to feel about the use of the computer for instruction. Further, an analysis of the specific attitudes and awareness levels indicate what groups the teachers fears are against using the computer and what groups the teacher feels need to have more information about what is going on in the schools. In answering these questions, many teachers questioned that there was any difference between teachers and staff, so the staff category will be eliminated.

The teachers generally felt that recognition was possible (Table II, page 136) as a result of using the computer for instruction. This was most frequently revealed by the Wichita nonusers who answered "yes" 75% of the time while the Shawnee Mission teachers were next with almost 74% and Wichita teachers at 72% with Shawnee Mission nonusers last with 50%. This question doesn't indicate any relation between users and nonusers. There seems to be no contribution that this question could make, so it will be dropped.

Paradigm Changes

The original paradigm has some overlaps in it that need to be

removed. In addition, there are categories that need to be rearranged. Further, clarification is needed as to how the factors relate to each other.

In order to improve the clarity of the relationships within the paradigm, the major factors will be presented in a flow chart format (see Figure 3). There seem to be three major factors in the paradigm. The first is the amount of use of the computer for instruction. This factor interacts with two others which also interact between themselves. The support that the teacher receives for using the computer is the next factor. The third factor is the attitude that the teacher has and perceives toward the use of the computer in the instructional process.

There are factors that indicate the amount of use of the computer, but there seems to be no other major factors that interact with it to affect the amount of use. There are factors, however, that seem to interact with the other two. Factors that interact with the support of computer use other than amount of use and attitude are the resources that are made available for the teacher to use and the accessibility of these resources to the teacher. The interaction here is one-way from the resources to the accessibility due to the fact that resources affect the accessibility but the accessibility does not seem to have any affect on the resources.

Factors that interact with the attitude toward the use of the computer for instruction include the influence that the teacher has and feels that others have, and the experience that the teacher has with the computer. The interaction is such that the attitude affects both of the others and both of the others affect it as well as each other.

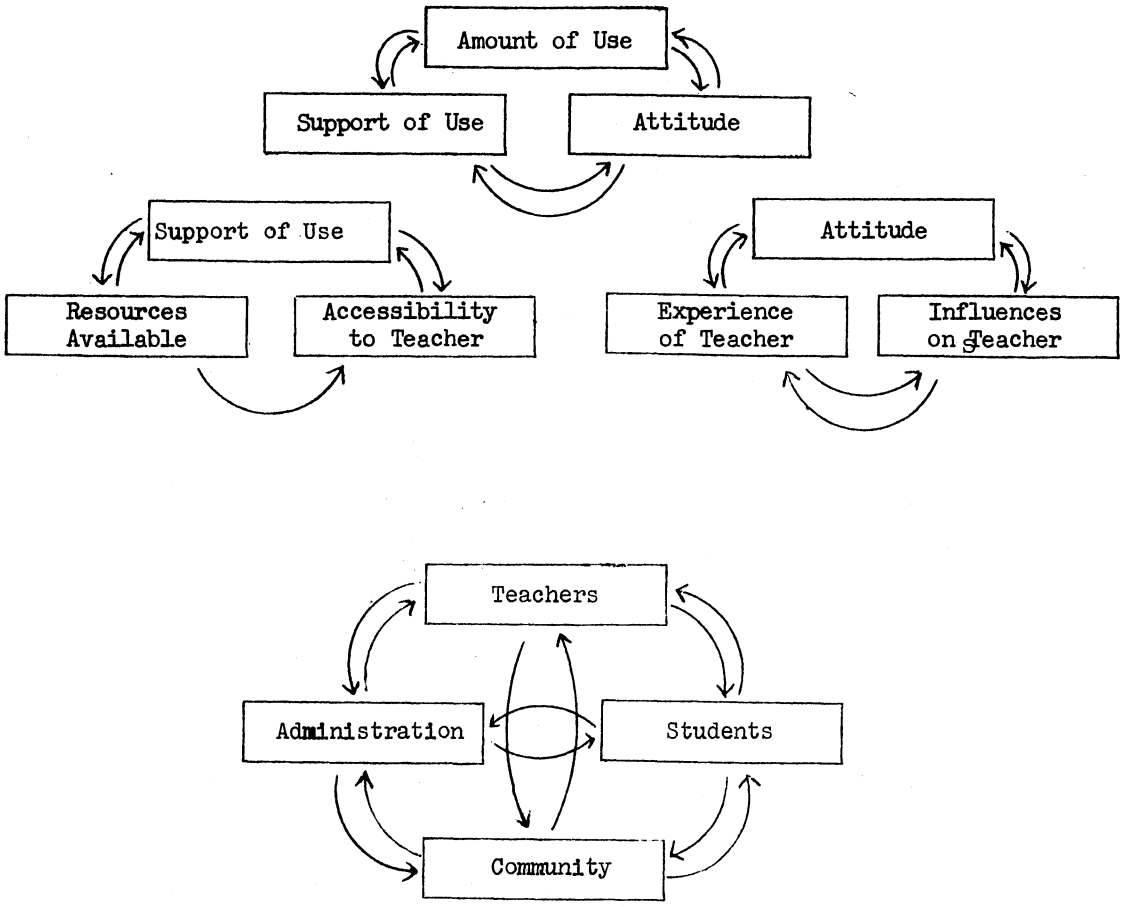

Figure 3. New Paradigm

The next significant interaction is the influences with which the teachers interact. These start with the other teachers and include primarily the students and the administration. The community is included as another major influence. These influences also affect each other so that all are interconnected.

The overlaps that were found to exist in the factors of the paradigm were fairly small. The separation of staff and teachers apparently is not accurate since most teachers asked how they differed when asked about the staff after being asked about teachers. In addition the amount that is available on the computer is a part of the resources rather than being a major topic. This would make the size and speed entries become duplicates of the storage ability and access ability categories.

The rearrangement that was indicated was also fairly minor for the original paradigm. However, the rearrangement that was indicated by the flow diagram was fairly extensive. This rearrangement was essentially with the same content as the original, though.

On the original paradigm, the interaction style of the teacher should be one of the ways or categories within the Ways the Computer is Used. The New Ideas category reflects the attitude that the teacher has and is not really a category with the support that the teacher receives.

In addition, the Amount Available on the computer category was shifted with the subtopics Size and Speed being under the category Resources. The changes that are indicated due to the flow diagram addition are detailed in the next section.

New Paradigm

The factors presented in Figure 3 are divided using the content of Figure 4. The amount of use of the computer for instructional purposes again is indicated by the amount of computer time used and the number of users of the computer for instruction. Of course, these can be broken down according to the same groups of factors as before. Thus the creation of materials could be separated from the actual classroom presentation and the actual student interaction with the computer presentation of materials. Likewise, the number of courses, number of students, and number of teachers indicate the amount of use.

The support of use of the computer for the teacher interacts with the amount of use (Figure 3) in that without support the teacher will not use the computer unless that teacher is exceptionally self-motivated to use the computer. It also interacts with the amount of use in that the amount of use of the computer enhances further use of the computer through the amount of resources that can be made available.

The attitude toward using the computer in support of instruction interacts with the amount of use also. When the teachers, etc., have a positive attitude toward using the computer in instruction, the level of use is likely to increase. In addition, it affects the amount of use by creating more support of use for the teacher. The amount of use affects the attitude toward using the computer due to the increased indication that the computer has value for instruction.

Thus, these three factors interact with each other to create increased use of the computer. The support of use is affected by increased use and can make increased use more likely. The attitude is affected by increased use and can make increased use more likely. Both of these

- Amount of Use
  - Time Used
    - Creating materials
    - Classroom activity
    - Student interacting
  - Number of teachers
  - Number of courses
  - Number of students
- Support of Use
  - Resources Available
    - Uses
      - Applications
      - Ideas
      - Types of Instruction
      - Languages known
    - Equipment
      - Computer speed
      - Computer size
      - Amount of storage
        - Immediate
        - Delayed
      - Programs available
        - Immediate
        - Delayed
      - Hardware
        - Speed
        - Size
        - Value to teacher
  - Accessibility to Teacher
    - Turn-around
    - Assistance
      - Regular
      - Courses
    - Input and Output
      - Equipment
      - Policies
      - Languages available
- Attitude of Teacher
  - Experience
    - Languages
      - Number
      - Time
    - Programs
      - Number
      - Size
      - Type
    - Classroom Use
      - Type
      - Amount
      - Number of Students
      - Interaction Style
- Influences on Teacher
  - Teachers
  - Students
  - Administration
  - Community

Figure 4. Factors Related to the Instructional Use of Computers

can affect the other as well so that increased support also improves the attitude and an improved attitude can cause increased support.

The support of the use of the computer as an aid for instruction not only interacts with the amount of use and the attitude, but it also interacts with the resources available and the accessibility of those resources. These factors do not interact with the amount of use and attitude except through the support of use. Support of use interacts with the resources available and the accessibility of those resources to the teachers.

The resources available in terms of using the computer in support of instruction interacts with the support and with the accessibility of the computer. The support of computer use is directly affected by the resources available since those resources are the main components of the support. Therefore the support affects the resources available through indications of what support is needed.

The accessibility that the computer has for the teacher has very little affect on the resources that are made available except through an indication of the support that is needed and therefore resources that are indicated by that support. The accessibility interacts with the support through the resources while it in turn is affected by the support since accessibility is the way in which the teacher becomes able to use the resources.

The resources available affect the accessibility since the resources must be made accessible before they can be used. However, the accessibility does not affect the resources except as indicated above.

The attitude toward the use of the computer for instruction not only interacts with the amount of use and the support of use. It also

interacts with the experience of the teacher and the influence on the teacher. These factors do not interact with the support of use and the amount of use except through the teacher attitude. The attitude toward use interacts with the experience of the teacher and the influence on the teacher.

The experience of the teacher interacts with the influences on the teacher both through the way in which the teacher interacts with the influences and also through the awareness that those who are influential with the teacher will have. The experience of the teacher also affects the attitude of the teacher due to the interaction that the teacher will have had with computers and people who work on computers.

The influences on the teacher interact with the experience of the teacher in that encouragement or discouragement will be given to increase the amount of experience. Further, the amount of experience is affected by the desire that the teacher has to increase his experience which is affected by the attitudes he encounters. In addition, the amount of experience that it will be possible to gain will be affected by the attitude of the constituency of the teacher. The affect that the influences have on the attitude of the teacher is psychological and the degree that they affect the teacher is strongly related to the teacher's concern about the attitude of others. However, even though the teacher may not care about the attitude of others they do have an affect on the teacher's attitude. Other factors such as the motivation of the teacher and the willingness of the teacher to do something in spite of opinions against it are assumed to enter into the values that the teacher presents for the attitude and awareness of the constituency.

The influences on the teachers are mainly the administration and students of the school. However, the community also influences the teacher through either the media or through direct contact that the teacher has with members of the community. All of these, including the teacher, has an affect on all of the others. At first, it seemed that the students did not affect the administration, but further analysis shows that much of what the administrators do is based on student reaction and action.

The interactions are shown in Figure 3 (p. 156) which is in the form of a flow diagram. The arrows and lines indicate the direction that the interaction takes while the boxes are the various items described above. This diagram shows that there are considerable interrelationships among all of the factors used in the paradigm.

The elements that reveal the above factors are shown in Figure 4 (p. 159). The amount of computer use is revealed by the time used in creating materials, classroom activities, and student interaction with the computer. In addition, the amount is revealed by the number of teachers, courses, and students that the computer is used with or by.

The elements that reveal the support and attitude are found at the lowest levels in Figure 4. The uses that could be made of the computer indicate the resources available and this affects the support. These uses include the applications that are available for a teacher to use, the ideas that a teacher has for using the computer, the types of instruction in which the computer materials present information, and the languages that the teachers can use to produce materials. The equipment that is available indicates the resources that are available also.

These include both the immediately available types and those that are available after a delay. The programs that are available are also affected by the immediate or delayed storage. The hardware that is used with the computer for input of information, storage of information, and output of information also indicates an amount of resources that are available. These can be analyzed in terms of their speed, storage size and the value they have for the teacher. The accessibility of the computer is the means by which the resources are made available. This includes turn-around time which is the time between presentation of a program to the computer and the return of the program and results after running on the computer. In addition the assistance that a user has greatly enhances his desire to use the computer. Part of this assistance needs to be in the form of courses or workshops in which the teacher learns about using the computer, but most of it probably needs to be in the form of regular help with problems that are encountered while working with the computer. The accessibility is mainly affected by the input and output of material to and from the computer. This is affected by the types of equipment that are used for input and output, especially the characteristics in terms of speed and the form of presentation of information. The policies that the operators of the computer establish also have a considerable affect on the accessibility that the computer appears to have. Another element that affects the accessibility is the languages that are available for the teachers to use. These can make the computer easy for the teachers to use or they can make the computer seem impossible for most teachers to use, even if that use is through a computer professional.

The experience that a teacher has with the computer affects the

attitude of the teacher as indicated earlier. The number of languages that the teacher knows and the amount of time that the teacher has known each gives an indication of the experience that the teacher has. In addition the number, size, and type of computer programs that the teacher has written indicates the experience that the teacher has. The type of classroom use, and the amount of classroom use, as well as the number of students that the teacher has made use of the computer with gives an indication of the experience the teacher has. The interaction style that the teacher has and that the teacher uses on the computer may also indicate the experience the teacher has.

The influences that the teacher encounters and responds to strongly affects the attitude of the teacher. The amount of these influences is indicated by the level of awareness that the teacher feels that the group has while the position that the teacher feels that the group takes is indicated by the attitude that the teacher attributes to the group. The groups that are likely to influence the teacher include the other teachers, the administration, the students, and the community. Their relative importance will probably be as listed in Figure 4.

CHAPTER VI

THE QUESTIONNAIRE

This chapter contains the description of the development process for the questionnaire. It starts with a presentation of the questionnaire (Appendix B), the selection of the jury, continues with the suggestions that were made, and concludes with a description of the improved questionnaire (Appendix C). These are titled Questionnaire, Jury Suggestions, and Resulting Questionnaire.

Questionnaire

The basic selection of components from the paradigm was done through the analysis of the interview results. The first group of questions need to determine the background characteristics of the teachers. Such questions as the number of students taught and the number of class periods taught will be used. In addition, the teacher's attitude concerning released time should be established.

The next section should determine how much contact the teacher has had with computer use. This should include their own experience as well as the experience of those that they interact with. It will be broken down as well into instructional or non-instructional use. In addition, the attitude that the teacher's friends and associates who use the computer have will be of value. The amount of experience that the teacher has with the computer would be useful.

The following section of the questionnaire turns to what the teacher would use the computer for and how much the teacher would expect to use it. The number of classes and the number of students with which the computer would be used would yield motivational information when compared with the above answers to similar questions. The number of programs that the teacher desires to make available for the students indicates the amount of use the teacher would like to make of the computer. The number of programs that the teacher would like to write indicate his motivational level as well as his willingness to overcome obstacles in order to use the computer. The number of programs that he would like for someone else to write indicates either that he would like for students to participate in the development of the materials or that he wants help from someone else in order to use the computer. If this figure is the same as the number of programs the teacher wants to write, he probably wants the students to be involved.

The next series of questions are for detecting the amounts of use that the teacher would expect to make of the computer. The difference between batch processing and interactive processing would probably indicate the degree to which the students would be using the computer instead of the teacher since the students are more likely to need the interactive system when the computer is used for instructional support. The amount of time that the teacher expects to spend on the computer before or after school hours indicates either or both his motivational level and amount of released time that he feels is available for developing instruction. The number of hours that students would spend before or after school hours would indicate how motivated the students are likely to be in working with this teacher on the computer. The

number of programs that would be stored on the computer for instructional use would indicate how much use the teacher intends to make of the computer in support of instruction.

The next question would determine what the teacher would actually be using the computer for in terms of support of the instructional process. Here the teacher would distinguish between the various types of possible uses of the computer by indicating how much use would be made of the computer for each. Categories that should be included here include: instruction, testing, drill, practice, managing instruction, statistical analysis, experimenting, problem solving, student programming, presenting material, interaction with material, similation, games, problem generation, and information retrieval for inquiry. An open category might be included to allow additions to the list.

The next questions would determine what types of support the teacher feels is needed and how often that support should be made available. The categories under which support could be provided include: learning to program, writing programs on a continuing basis, designing instruction for computer implementation, and implementing programs on the computer. The response form should probably be something like daily, weekly, monthly, quarterly, or yearly.

The last two questions would determine the level of awareness that the teacher perceives that the constituency has and the attitude that the teacher feels that the constituency has. Here the constituency is categorized into administration, teachers, students, and community. The response for the attitude would be the same as that used on the interview, i.e. very negative to very positive and the response for the awareness would be a percentage as it was on the interview.

Jury Selection

A jury contributes to the development of a questionnaire through its analysis and suggestions about the instrument. Each person of the jury is selected for a particular expertise that he or she can contribute to the analysis. The persons selected for this jury included research experts, educators, and teachers with no computer awareness. There were three persons who were selected as experts in research and two each who were educators and potential research subjects. One was selected as a computer expert, also. Two secretaries also contributed in terms of the format of the instrument.

The research experts included the research coordinator for the Oklahoma City Public Schools, the coordinator of research and planning for the Tulsa Public Schools, and a research assistant in the Tulsa system. The computer expert was the Director of Computing Services in the Oklahoma City system.

The educators included a graduate assistant at Oklahoma State University who was studying media and a teacher in the Wichita Public Schools who has considerable computer interest and knowledge. The potential users included a principal in the Sperry High School who has considerable secondary teaching experience but no computer knowledge and a teacher in the Sperry Elementary School who has taught only a few years and also has no computer knowledge.

The secretaries worked in the Educational Materials Center in the College of Education at Oklahoma State University. They both had some media knowledge, some secretarial experience, and intend to become teachers.

The jury members were asked to analyze the interview in terms of the value of each question, the readability of the questionnaire, the ease of use of the instrument, and the clarity of the questions. They were also asked to analyze questions in terms of their value, to detect trivial questions, to find oversights, and to see if a readily available documentary source would give the same information.

The experts contributed mainly in terms of oversights, triviality, documentary sources, and value. Educators made their contributions in terms of value, clarity, and documentary sources. Potential users contributed mainly to ease of use, readability and clarity.

The jury members were interviewed individually and their responses were recorded on paper by the researcher. A summary of these responses appear in the next section.

Suggestions

The educators were interviewed first and corrected many errors. They also suggested that instructions be added and that the instructions include details of response recording as well as suggesting that such terms as "batch processing" and "terminal" be defined. One suggested that some additions be made such as "grading" in question 20 (see Appendix B), and subject matter and grade correlations be added.

The research experts emphasized that the marking of the questionnaire should be clarified. One suggested that it was too vague and that the teacher needed another response alternative, such as "don't know." Another felt that the very positive to very negative continuum was unclear while the third felt that the marking instructions should be clear and specific. The third recommended that a continuum be used only for attitudes and blanks be used where numbers are requested.

Other recommendations the research experts agreed on were that the analysis procedure be specified and that the terms be defined. They felt that the computer terms would not be understood by teachers although one felt that high school teachers would understand it better than elementary teachers would.

One recommended that the instructional medium concept needs more emphasis. He also recommended, as did one educator, that the subject areas should be brought out by the questionnaire.

The computer expert felt that a glossary of terms was needed in order for teachers to understand the instrument. He recommended that a question concerning the teacher's impression of computer use might be added. He also suggested that a question to determine self-motivation would be valuable. He also suggested some minor changes.

The high school teacher with no computer background also suggested that many terms be defined. He wanted another response alternative for questions that do not apply. There were some questions that he felt were too nebulous for a "computer ignorant" teacher to answer. He also suggested that the continuums be clarified.

The elementary school teacher also had no computer knowledge. She recommended that many terms be defined such as: batch, terminal, possibilities for use, program, and percentage of awareness. She also suggested that the continuum be clarified and that some minor word changes would be helpful.

The secretaries made changes that helped considerably in terms of readability. One placed the questions on the left side of the page with the response blanks on the right. The other modified the continuums into uniform categories and placed them in an orderly format. This

reduces the continuum look and yet leaves it as a possibility if someone decides that the continuums are needed.

New Questionnaire

The new questionnaire is provided in Appendix C. This section will describe the new questionnaire, its background, instructions concerning its use, and analysis techniques. The new questionnaire resulted from the incorporation of the jury suggestions into the original questionnaire.

In most cases, the subject checks a box in answer to the questions. In a few, the subject writes a number in a space. The terms that are likely to be misunderstood are defined in a glossary which includes the negative-positive continuum. The instructions were added and modified to give the subject a "way out," to specify what marking procedure was to be used, and to indicate the glossary.

There are two new questions at the beginning to determine what subjects are taught and where the teacher feels that the computer should be used. Questions 3 and 4 are the same as questions 1 and 2 on the original (see Appendix B). Question 5 determines what grade level the teacher teaches. Questions 6 through 12 are from the original questions 3 through 7 with the exception of the two attitude questions, one after each 9 and 11 which were in 6 and 7 on the original. Question 13 is also an attitude question that has been added. Questions 14 through 28 are questions 8 through 22 on the original. The question concerning types of instruction (number 19 on the original) was moved to keep it intact on a page. However, it also was moved so as not to break a series of questions.

Background

This questionnaire is designed to be answered by classroom teachers who do not use the computer in instruction. The results of the questionnaire will be useful for determining whether the teachers in the school or system would be willing to use the computer in instruction.

The questionnaire could be distributed from any level, but best results would be obtained if the agency that would provide the computer sent the questionnaire. The suggested analysis procedure follows the instructions for the use of the questionnaire.

Instructions

A cover letter must be added to the questionnaire. It should explain the motivation for answering the questions and it should detail the procedure by which the completed questionnaire is to be returned. There should also be a deadline set forth.

The questionnaire is designed to be answered by teachers. The administration of the questionnaire should be performed by personnel at the level that would purchase the computer.

The questionnaire should be printed in as little space as possible without making it difficult to work with. Probably the simplest technique would be to copy it on the front and back of three sheets.

The glossary is an integral part of the questionnaire. Most teachers have not yet encountered the computer other than as the object of its operation. Therefore they have not encountered CAI and computer technology terms.

Analysis

The administration of the questionnaire concludes with the presentation of the results. In order to present the results, the answers must be transformed to statements about computer usage. The suggestions given here are only helps in analysis. Actual values that indicate a likelihood that a teacher will be a user have not been proposed. No correlations have been established for questions. However, the suggestions do imply correlations.

Questions 13 and 22 indicate the teacher's motivation to use the computer. Questions 17 through 19 indicate the ideas of things that the teacher wants to do with the computer. Questions 3 and 4 indicate the potential students and classes the computer could be used with. Question 6 indicates possible creation time for a teacher to use. Questions 7 through 12 indicate expected usage as do 20 through 25. Question 26 indicates levels of assistance the teacher feels would be necessary. Questions 27 and 28 indicate the support that the teacher expects to get from others for using the computer in instruction.

Questions 1 and 2 are: "1. Mark the subjects you teach with a 'T', 2. Mark the subjects in which you feel the computer should be used with a 'C'." The differences between what the teacher feels the computer should be used with and what the teacher teaches in these questions are used in analyzing the responses to these questions. If the teacher does not feel that the computer should be used in the area that he or she is teaching, then the chances that the teacher will use the computer are reduced.

Questions 3 and 4 are: "3. How many students do you teach per day? 4. How many class periods do you teach per day?" On these

questions, if the teacher has less than 75 students, the efficiency of computer usage is reduced. If the ratio of 3 to 4 is above 25, the teacher probably can't allow individual interaction such as the computer. If the teacher is responsible for more than 5 classes, then the answer to 13 must be very positive, the answers to 17 through 19 and 22 must be high since the teacher doesn't have much time for curriculum planning.

Questions 5 through 8 and 14 are: "5. What grade levels do you teach? 6. How many hours of release time (planning period, etc.) do you currently receive per month? 7. How many hours have you spent using the computer in instruction? 8. How many hours have you spent using the computer? 14. For how many years have you known a computer programming language?" For question 5, many authors feel that teachers below a grade level of 10 are unlikely to use the computer. Less than 16 on question 6 indicates a lack of time that could effectively be used for developing new instruction. However, a large number in 22 could counterbalance this. In questions 7, 8, and 14 a large value may indicate an interest in using the computer in instruction. Support from 13 would be needed to justify interest in using the computer in instruction.

Questions 9 through 13 are: "9. How many people do you know who make direct use of the computer for any purpose? 10. What is their attitude toward using the computer? 11. How many people do you know who use the computer in instruction? 12. What is their attitude toward using the computer? 13. What is your impression of the use of the computer as an instructional medium?" The attitude of the teacher in questions 9 through 12 will be influenced by the combination of the

number of people that the teacher knows who use the computer and their attitude. If both are large and positive or small and negative, then the teacher attitude is likely to be positive or negative, respectively. However, the teacher's own attitude in question 13 may differ from what others who use the computer feel. This attitude can overcome many obstacles such as lack of released time, heavy teaching load, and a lack of students to teach.

Questions 15 and 16 are: "15. In how many classes would you use the computer? 16. How many students would you expect to use the computer for your classes?" These questions can be used to find the efficiency of computer use through the number of students divided by the number of classes. A large result implies possibilities for efficient usage.

Questions 17 through 19 and 25 are: "17. How many computer programs do you know of that you would use in your classes? 18. How many computer programs would you like to write for your students to use? 19. How many programs would you like to have someone else write for your instructional use? 25. How many programs would you store on the computer for instructional use?" For these questions large numbers in any or all indicates interest in using the computer in instruction. However, a small number for 18 or a large number for 19 indicates that the teacher wants someone else to interact with the computer. Large numbers for 17 and 25 indicate a desire to use the computer.

Questions 20 through 23 are: "20. How many hours of use would you and your students make of a batch processing system per day? 21. How many hours of use would you and your students make of an interactive terminal type of processing per day? 22. How many hours per day would

you expect that you would use the computer before and after school hours? 23. How many hours per day would you predict that your students would use the computer voluntarily, on the average, before and after school hours?" For these questions a large number on 20 indicates that computer science or problem solving will be emphasized by the teacher. A small number on 22 implies a lack of motivation on the part of the teacher. A small number on 23 indicates a feeling that students are not motivated.

Question 24 is: "How many hours per week would you and your students make use of the computer for the following?" An emphasis on the first three categories of question 24 indicates that CAI, or teaching by computer, is of interest. The next four indicate an emphasis on the computer to support traditional education. The remainder imply a new type of instructional process and yet are not CAI.

Question 26 is: "How much assistance would you need in the following during the year after a computer became available for your use? Small numbers in the categories of question 26 indicate either a lack of desire to interact with the computer or a feeling of confidence in using the computer. A positive response to 13 would indicate the latter while a negative or neutral response would indicate the former. These answers are also useful for planning in-service and consultation activities since they indicate what teachers feel are reasonable amounts of training, with some exceptions.

Questions 27 and 28 are: "27. What do you feel is the level of awareness of the following to the use of the computer as an instructional medium? 28. What do you feel is the general attitude of the following to the use of the computer as an instructional medium?" In these

questions the level of awareness seems to be related to the attitude as was pointed out in the review of the literature. Here the teacher feelings indicate what the significant others think of using the computer in instruction. A high value of awareness indicates that the feeling will have more effect on the teacher. However, most teachers will be affected more by other teachers than the other people.

Indications from the interviews produce the following tabulation expectations for the questionnaire (Appendix C). Question 1 will probably emphasize mathematics and science as will question 2. However, question 1 should cover all areas that are represented in the schools proportionately. Question 3 will be in the 101-126 range mostly with many in the 126-150 range for upper grades. For elementary school, the 0-75 range is most likely.

Emphasis on question 4 will be at the 4.5 range. Question 5 again should reveal a proportionate response to the actual distribution of the group. The emphasis is likely to be in the 10-12 range. Question 6 emphasizes the 16-25 range. Question 7 will emphasize the 0-25 range as will question 8.

Question 9 will emphasize the 0-15 range and question 10 will be on the positive side. Questions 11 and 12 will be the same. Question 13 will average slightly positive. Question 14 will emphasize the 0-2 range.

Indications are that normal use of the computer as in question 15 will be in the 2,3 range, but the emphasis of the answers will be in the 0,1 range. The normal use as well as the emphasis for question 16 is in the 0-75 range. For question 17, the knowledgeable teacher would be in the 26-50 range whil most of the answers will be in the 0-25

range. Questions 18 and 19 have the same result as 17.

Questions 20 through 23 have no precedents, but are useful for planning computer availability. Question 24 is also used for planning purposes, but the indicated emphasis is on drill and practice, testing and grading, simulation, and games. For question 25, normal usage is in the 76-100 range while indications are in the 0-75 range.

Indications for question 26 are that learning to program takes about 30 days of in-service with about two hours per week of consultation. Writing programs takes no additional days, but requires about two hours per week. Designing instruction takes another 30 days and two hours per week while implementing instruction takes two hours per week and no in-service.

Question 27 generally has administration high and community low with students and teachers about the same. In percentages this comes out 80% for administration, 50% for teachers, 45% for students, and 25% for community. Question 28 had the same trend with administration most positive, but teachers were least positive with students more positive than the community. However, the interview result was that teachers were barely positive and administration was nearly very positive which kept all in the positive range.

All items with five entries can be reduced to an average position within the entries. This can be accomplished by assigning the leftmost box a zero and adding one for each box to give the rightmost box a four. The tallies for each box (t), times the value for the box (v) gives values that can be added together to find the average. The average (A) is the sum of the tallies divided into the sum of the tallies times the values, thus:

$$A = \frac{\Sigma(t \times v)}{\Sigma t} .$$

This result is the position on the zero to four continuum that was created above at which the average response was. Thus, an average of 3.41 would indicate the 76-100 range for question 8.

For a translation into a numeric value within that range, the following calculation gives a very approximate numeric representation for the average. Mark out the number before the decimal point and multiply the remainder times the range for the box. This result added to the first number gives an approximate average for the question. The 3.41 for question 8 translates to 85 as follows: the range is 100 - 76 = 24 and the remainder is .41; these multiplied give 9.8 which added to 76 gives 86 for an indicative average for question 8.

For questions 1 and 2, tallies are the only meaningful data. Questions 26 and 27 could be averaged directly for presentation. All other questions could be presented using the indicative average or the positional average found above.

CHAPTER VII

CONCLUSION

This chapter contains a summary of the research, including the literature review, the paradigm, the interview, and the questionnaire. The implications of the research and the resulting recommendations are also presented.

Summary

There were four major activities undertaken in this research. The review of the literature basically supported the tentative paradigm presented in the introduction. The paradigm was used to develop both the interviews and the questionnaire. The interview results and analysis of the paradigm were used to improve the paradigm. The improved paradigm was used to develop a questionnaire which should be useful in determining whether a teacher, a school, or a school system is likely to use the computer enough to justify the acquisition of a computer or access to a computer.

Literature

The literature dealt mostly with positive and negative aspects of computer use in instruction and presented suggestions for solutions to educational and CAI problems. This emphasis was due to the lack of studies that dealt with factors affecting decisions to use the computer

as an instructional medium. The studies that have dealt with these factors emphasize the attitudes of potential users, whether they be at the administrative or teaching level.

The positive aspects or values of computer use emphasized the use of the computer for individualization. There have been many studies of the psychological aspects of individualizing as well as studies of the practical aspects such as subject and media characteristics. The great potential that the computer offers both in terms of providing enrichment for the teacher and in terms of providing a uniform, unchanging, and impersonal interaction were also presented. Of course these overlap not only with other positive aspects but also with negative factors and solutions.

The negative aspects or problems encountered in computer use as an instructional medium have their main source in attitudes or degree of acceptance of new ideas. Another source is technical problems of both hardware and software. This results in a lack of materials and equipment appropriate for CAI type activities. Hurdles that must be overcome include: cost, man-machine interface, and myths about the computer and CAI. A lack of communications encourages or enhances all of these problems. In addition, the feeling that allowing evolutionary development to run its course will solve the problems and the organizational structure both inhibit the growth of computing and CAI in education.

The bulk of the solutions present specific educational uses of the computer. However, the evolution of CAI has considerable discussion. Research and systematic analysis based on theory also are given emphasis in the literature and training is seen as an important resource.

Another way of looking at the literature is in terms of the support it gives for the tentative paradigm (Figure 1, page 3). The three major categories (Amount, Teacher, Administration) were not evenly distributed with the emphasis being placed on Administration and with subcategory emphasis in the Teacher and Administration categories.

Within the Teacher category, the emphasis was on the Support and Attitude subcategories with almost no literature presenting the Experience with Computer subcategory. The Support category had emphasis on all subcategories except New Ideas. There was little presented within the subcategory of the Ways the Computer is Used although the category itself had considerable emphasis. The subcategories of the Attitude category had little emphasis themselves also.

The Administration category had most of its emphasis on the Interaction with the Computer, Amount Available on the Computer, and Programs Available subcategories. The Support of Teacher subcategory had little emphasis and also lacked emphasis on any of its subcategories. Within the Support of Computer Use category the Accessibility subcategory lacked emphasis. However, the Interaction with the Computer subcategory of Accessibility was emphasized. The only subcategory within the Amount Available on the Computer category that had emphasis was the Programs Available subcategory.

The literature presents many positive aspects, negative aspects, and solutions which support the tentative paradigm to varying degrees; but the literature does support the final paradigm (Figure 3, page 156).

Paradigm

The initial paradigm (Figure 1, page 3) was simply an outline of

those factors that had been discovered through analysis of the literature, conversations with various people, considerable thought, and much analysis. This paradigm presents three main categories: Amount, Teacher, and Administration. These categories are then subdivided to indicate finer divisions.

The new paradigm (Figure 3, page 156) shows the interactions of the major factors while Figure 4 (page 159) shows the relation of these factors to factors in the instructional use of the computer. Figure 4 is parallel to Figure 1 in being an outline of factors. In Figure 4, however, the major factors come from the new paradigm and are Amount, Support, and Attitude. The new paradigm and the subdivisions in Figure 4 were suggested by further analysis of the literature, analysis of the interview results, and additional analysis of the original paradigm.

In the new paradigm, there are three levels of factors. The first level contains the categories Amount of Use, Support of Use, and Attitude. Amount of Use is not subdivided while the others are. The Support of Use category interacts with Resources Available and Accessibility to the Teacher. These are not subdivided in the paradigm. The Attitude category interacts with the Experience of the Teacher category and the Influences on the Teacher. The Influences on the Teacher category is further divided to show where these influences are found. The teacher interactions, which are the major influences on a teacher, interact with the Administration, Students, and the Community to affect their interactions with the teacher also.

The other factors in Figure 4 are indicators of the factors in the paradigm. The paradigm contains the major factors while Figure 4 presents

all the significant factors related to the factors of the paradigm. These significant factors could be used in measuring the paradigm factors.

Interview

The interview schedules were developed from the tentative paradigm and the results of the interviews were used as input in creating the new paradigm. The interviews were written to gain the information that was needed to analyze the quality of the paradigm in terms of its ability to explain a teacher's decision to use or not use the computer as an instructional medium.

The interviews were conducted in schools which used the computer as an instructional medium in order to find what factors were useful in explaining a teacher's decision to use or not use the computer. Most of the teachers interviewed were using the computer while nearly all wanted to use it.

Most of the 51 teachers interviewed desired to use the computer. The teachers were generally teaching five classes per day with an average of 25 students in each and were mainly teaching mathematics or science although most subjects were represented. The computer was being used in mathematics classes, mainly, in Wichita, while it was being used in most subjects in Shawnee Mission. Those Wichita teachers who were using the computer were using it in about half their classes while Shawnee Mission teachers were using it in most of their classes.

The computer using teachers spent an average of about seven hours per month preparing computer mediated instruction materials while Wichita teachers spent about two and a half hours per month presenting

materials that were stored on the computer for presentation and Shawnee Mission teachers spent around 40 hours per month presenting computer materials. This difference is due to the fact that Shawnee Mission teachers prepared ditto masters of the computer prepared classroom materials and used the copies in class while the Wichita teachers had the students writing programs and therefore only taught them to program in class.

Teachers generally received one hour per day for a planning period. About one-third of the Wichita teachers and one-seventh of the Shawnee Mission teachers felt that this was released time. One teacher used part of the planning period for preparation of computer mediated instruction. However, both districts held workshops during the summer in which teachers could learn to use the computer. A little less than two-thirds of the teachers felt that released time would be necessary in order to use the computer. Shawnee Mission teachers felt less need since they did not interact with the computer in developing their materials.

In Wichita, about one-fifth of the classes were using the computer while about one-third in Shawnee Mission were. Wichita students were using the computer about six hours per month while Shawnee Mission students were using it three hours per month. This is surprising since the Shawnee Mission students interacted with the computer in almost no classes other than computer science. Apparently the computer science classes were overrepresented in the Shawnee Mission sample. Teachers in Wichita recommended that students use about 12 programs per month while Shawnee Mission teachers recommended a little over three. Again, the amount for Shawnee Mission is surprising.

The styles of interaction that teachers felt that they had with students differed in Shawnee Mission and Wichita. Both groups generally felt that they were open and flexible. However, the Wichita teachers felt that their interaction was formal and presenter-oriented while the Shawnee Mission teachers felt that theirs was friendly and student-oriented. Wichita teachers felt that the programs that they wrote for interaction with the computer had the same interaction style as the teachers had in the classroom. However, the Shawnee Mission teachers felt that the computer interaction was the opposite of the Wichita teachers except in the student-oriented category. This meant that the Shawnee Mission teachers reversed their interaction style when using the computer except in the student-oriented category.

Wichita and Shawnee Mission used the computer as a tool, for problem solving, and for simulation and games. However, Wichita emphasized student programming while Shawnee Mission emphasized managing instruction. The programs that teachers wrote reacted to student input generally and they had no programs that modified the interaction based on input as well as little that presented material only.

The teachers generally wanted simulation and game interactions added to the computer. Wichita teachers wanted more programs that presented information. Shawnee Mission teachers generally wanted extensions of current programs which basically were managing instruction. They felt that they needed time to create these programs. Shawnee Mission teachers also felt they needed more equipment.

The teachers had written an average of about 16 programs and felt that they had an average of 40 programs available. Wichita teachers knew and used Basic while Shawnee Mission teachers knew and used APL.

Shawnee Mission teachers did not write programs themselves, in general. Wichita teachers had known Basic an average of about seven and a half years and had written an average of 70 programs with it while Shawnee Mission teachers knew APL an average of about three and a half years and had written an average of about 100 programs with it. This is possibly due to the ease of use of APL as well as the nonrepresentative teachers who were interviewed in Shawnee Mission.

The attitudes were generally positive on the very positive to very negative continuum. Wichita teachers felt that their community was aware of the computer at a 15% level while Shawnee Mission placed their community at 30%. Otherwise, they felt that awareness was about the same with teachers around 55%, administration around 80%, and students around 45% aware of the computer as an instructional medium. The difference in community awareness is probably due to the debate that the Shawnee Mission school board was having about the computer.

Most of the teachers were uncomfortable about gaining recognition for using the computer. They avoided personal recognition for using the computer by saying that someone else such as an active teacher or a student might get recognition. The impact that the teachers felt that the computer could have was basically said to be considerable and beneficial. The specifics that both sets of teachers gave were individualization and motivation. The Wichita teachers noted that the students would gain understanding of the computer which was achieved through their learning of concepts by teaching them to the computer. The Shawnee Mission teachers pointed out the change in the teacher role as an important impact that the computer could have.

The teachers generally wanted more equipment and materials if they were to be given unlimited resources. The Wichita teachers added that they would learn more about using the computer and would make more available for others to use.

In analyzing the interview, the teachers indicated that they preferred the open-ended questions. They generally did not like some of the terminology and the interaction and attitude questions. Some Shawnee Mission teachers felt that parts of the interview were repetitious. The teachers had expected more anecdotal questions and more questions about teacher attitudes. Teachers in Wichita felt that questions about student learning and teacher motivation should be added while the Shawnee Mission teachers felt that questions to detect problems were needed.

These results indicated that questions to gain the following information should be included on the questionnaire as well as contributing to the paradigm. The questions determining the level of computer use indicate that questions about potential use are needed. The questions about released time and assistance needed would aid in determining what blocks teachers felt existed or would stop them from using the computer. The possibility that a teacher would desire to create instructional uses of the computer needs to be detected. Questions concerning the types of computer interactions the teacher wants students to have will give an idea about the amount of computer use likely. The awareness a teacher has of computer possibilities seemed to be related to the likelihood that they would use the computer. This question is needed. The fact that teachers did not like the attitude and awareness questions is explained by their difficulty in understanding

them. These questions contributed to making distinctions between users and nonusers and have many other potential contributions such as pinpointing what significant group teachers fear will disapprove of computers in instruction.

Questionnaire

The questionnaire was based on the new paradigm and the results of the interviews. The new paradigm as well as the interview results have been presented above. The interview results also were used in improving the paradigm. The main input for the questionnaire was the results of the interviews.

The groups of questions that should be included are as follows. The background characteristics of the teachers are needed for contrast with computer use desires. The amount of contact a teacher has had with the computer indicates generally how firmly his opinions about computer use are established. Potential uses and amounts of use are of fairly direct value, even in planning potential computing needs. Even nonusing teachers with a poor conception of these matters have some idea of how much they would use the computer. Questions concerning interaction style, both of the computing system itself and of the programs available on the computer, contribute to the previous questions. The types of support the teacher feels are needed indicate the teacher's potential involvement with the computer and its programs. Again this could contribute to planning in addition to being directly indicative. The attitudes of others have considerable effect on those teachers who are basically neutral on the above questions. A highly motivated teacher, as revealed on previous questions, will probably ignore

attitudes of others until those attitudes are a fairly direct influence on him or her.

The jury was selected to gain expert opinions about the validity of the questionnaire. It consisted of three research experts, two nonusing teacher experts, two professional educators, and one computer expert. Two potential teachers with secretarial expertise also tributed significantly. The jury members were asked to analyze the questionnaire in terms of its coverage, value, readability, and ease of use. They were also asked to watch for trivial questions, oversights, and questions that duplicate information that is readily available from another source.

As a result of the jury analysis, additions and changes were made to the questionnaire (see Appendix B) to produce the new questionnaire in Appendix C. The format of the questionnaire was modified to be more readable and easier to use. New questions were added to determine subject matter feelings of the teacher concerning the computer, the grade level which is taught, and attitudes of users the teacher knows as well as the teacher's own attitude. The instructions for use and the glossary were also recommended by the jury.

Instructions for using the questionnaire are included in Chapter VI of this paper. These instructions include an explanation of the questionnaire including its purpose, instructions for the cover letter and printing the questionnaire, and suggestions for analyzing the questionnaire responses.

Implications

This research started as an attempt to determine what was inhibiting

the use of the computer as an instructional medium. Upon seeking a basis for determining these factors, no research could be found and there was no theory base available for developing instruments to use in finding the source of the inhibitions. Therefore, an analysis of the literature was made to find what factors are felt to affect the use of the computer as an instructional medium. From this analysis a tentative paradigm was produced. The paradigm was used to develop interview schedules for the purpose of testing and improving the paradigm. The interview results were also used to aid in the development of the questionnaire. The resulting paradigm is a start toward the desired theory. The paradigm and interview results were then used as input in the design of a questionnaire. The questionnaire was validated through the jury technique as well as the above research. The resulting paradigm (Figures 3 and 4, pages 156 and 159) provides at least a start in the direction of a theory to explain the inhibitions that exist in moving toward the use of a new technology. An additional resource is the EDUCOM report by Anastasio (1972) about factors inhibiting computer use.

The questionnaire that has been presented (see Chapter VI) can be a valuable planning tool for school systems that are interested in the amount of instructional use their teachers might make of a computer. It can also give valuable information in the implementation of a computer system for teachers to use. The questionnaire can also serve as a tool for analyzing and improving the paradigm.

Since there also seems to be no theory base for determining the likelihood that teachers would use other media, this research and the resulting paradigm provide a resource that would be useful for developing a more general theory.

The fact that attitudes contributed so strongly in the findings implies a need for a more thorough study of psychological factors associated with inhibitions. The ramifications here extend to the possibility that by overcoming inhibitions, real humanness might be brought to the surface. Of course, real humanness might be argued to include inhibitions, but this argument would underscore the need for research to seek to gain control over inhibitions.

Recommendations

This section contains suggestions concerning the use of the computer for instruction and additional research possibilities for which this research implies a need. The suggestions present the questionnaire as a tool for improving the probability of success for using the computer, turns to the humanization problem, and concludes with the computer as a tool. The additional research possibilities were generally suggested by things that were not possible in this research.

Suggestions

The computer is being used in many school systems as part of the instructional system. Some school systems have already tried the computer and decided that it was not appropriate for them. This probably resulted from the lack of a broad base of attitudinal support for the use of the computer for instruction. At least one aspect of this broad base could have been established through the use of the questionnaire developed here. The amount of teacher use and its type could have been predicted and an expensive trial could have been avoided. More important than the expense though, is the sour taste left with

those teachers that did use the system successfully and then lost it.

To buy a computer with the intention of saving money by increased efficiency assumes that the instructional process available on the computer is more efficient than the traditional materials used. The lack of good materials on the computer is only underscored by the general lack of good materials for learning. Transferring materials to an interesting source or an efficient transmitter does not improve the quality of the materials. However, the development of good materials can be enhanced by the use of the computer to detect characteristics of good interactions (efficient) between the student and the materials. Up to this time, optimum organization and interaction of materials has been determined by the curriculum writer. Now it is possible to test for the optimum organization and interaction dynamically while students are learning. This does not mean that the computer isn't a good instructional medium, but that it is not a panacea.

To buy a computer for the purpose of serving both instruction and administration assumes that the representatives of instruction in administration are seen by the administration as having as much power for maintaining instructional use as there is power for administrative uses. I. e., if the computer is administered by the Curriculum Director, it will emphasize instruction from an administrative point of view; if a committee of instructional users with the same power as a committee of administrative users direct his policies, the emphasis would probably change.

In other words, the organization for using the computer in instruction is as important to its success as is the attitude about its use. Thus, finding that the teachers want to and will use the computer doesn't

guarantee that they will ever get the opportunity. The only way to guarantee such an opportunity would be to give them any support they request in terms of equipment, software, organization, and finances. A compromise in which the teachers have as much input in terms of power would probably be the next most likely to succeed.

This is not to say that a centrally administered system won't work. There are many administrators who can serve as well as the committee of teachers to present their desires and insure that a compromise suitable to insuring that teachers get to use the computer as an aid in their instruction will be found. This merely re-emphasizes the fact that the critical factors for success are the people involved rather than the technology they use.

The computer is simply a tool that is available to the teacher to use as an aid in instruction. Any dehumanization that occurs as a result of using these tools can only come from the human beings who are using them. The book and the blackboard are not considered to be dehumanizing even though they are technological enhancements that educators use. Computer interactions dehumanize only to the extent that the person interacting with the computer feels that it is a machine controlling him. The apparent controls were developed and installed on the computer by a human being. If the interaction dehumanizes, it is because the human creator was not able to create a humanizing interaction using this tool.

In any case, computers are now a part of life for much of the world, and especially in the United States. To ignore the existence of this tool is to present a distorted view of the world to students. Frequently they know that the schools present a distorted view and therefore use

the school as a social agency or ignore it. Some students use the school as the tool it is and learn what they need for life in spite of the distortions. In other words, using technology poorly or ignoring it reduces the effectiveness of today's schools because the students normally have considerable interaction which is generally good with technology.

The schools are actually cheating their students if they don't offer a balanced view of technology to students in school. This is impossible to do without giving them actual experiences with that technology. In addition, technology is the source of many valuable and powerful tools to assist the educator who wants to be a humanizing force in the schools.

Additional Research Possibilities

The suggestions for analysis of the questionnaire results have no experiential basis. This could be provided by longitudinal studies which relate various quantitive values to the success or failure of a CAI effort in a school. These numerical indicators could even be established for individual teachers so that teachers who are not likely to succeed using the computer could be given a different alternative. The longitudinal studies would trace the teachers' experience with the computer and compare the experience with questionnaire indicators. This comparison would establish which factor(s) is(are) in force. Approximate values at which the teachers change from failure to success should be found from this. This follow-up could be done in Wichita and Shawnee Mission using the results reported here.

Further analysis of the interview results may reveal additional

interactions that are noteworthy. For instance, the attitude interactions may be more extensive than was reported here or they might extend the flow diagram to another level.

In addition to verifying and quantifying the paradigm presented here, research is also needed which would extend the paradigm to media in general or even to a theory of inhibitions. These theories provide bases for improving the probability of success of innovations both in terms of checking to see if an innovation is likely to succeed with a certain group and in terms of creating a favorable climate for an innovation to succeed.

Another possible contribution could be in terms of the attitude and awareness concepts. There were apparent trends that indicated that awareness and attitudes were related. A follow-up study using these concepts could also contribute in a theory about inhibitions.

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APPENDIX A

TEACHER AND ADMINISTRATION INTERVIEWS

TEACHER INTERVIEW:

The purpose of this interview is to determine what factors may have an affect on the use of the computer as an instructional medium in the classroom. The use of the computer as an instructional aid refers to the application of the computer to the instructional process as a tool for aiding the teacher in the presentation of course material.

Answer the following questions to the best of your knowledge at this time.

(The code A refers to questions which should be asked of all teachers, the code D refers to questions to ask only those that don't use the computer, the code U refers to questions to ask only those that use the computer, and the code Y refers to questions to ask if the preceeding yes or no question was answered with yes.)

1. A Have you ever used the computer as an instructional aid?

2. A Do you currently desire to use the computer as an instructional aid?

3. D Would you like to use the computer as an instructional aid if you were given appropriate circumstances?

4. A How many class periods do you teach per day?

5. A How many students do you teach, total?

6. A What subjects do you teach?

7. U In what subjects do you make any use of the computer?

8. U How much time per month do you spend using the computer in preparing materials for instruction?

9. U In how many classes do you use the computer as an instructional medium?

10. U How much classroom time do you spend in presenting materials that were stored on the computer for classroom use?

11. A How much released time are you given per month for development of instruction?

12. U How much released time are you given per month for development of instruction that uses the computer as an instructional medium?

13. U Have you ever been given released time for development of instruction that uses the computer as an instructional medium?

14. A Do you feel that released time would be necessary for you to use the computer as an instructional medium?

15. U How many of your students are using the computer as an instructional medium in your classes?

16. U How much time does your average student work on the computer for your classes per month?

17. U How much time do all of your students work on the computer for your classes per month, total?

18. U How many different existing computer programs do you suggest or assign your students to use in a month?

19. U How many computer programs have you written to be used by students?

20. U How would you characterize the interaction style of computer programs you have written with students in terms of an open-ended to closed continuum?

21. U How would you characterize your computer program interaction style in terms of a flexible presentation to strict flow con-

22. U How would you characterize your computer program interaction style in terms of a friendly conversation to formal presentation continuum?

23. U How would you characterize your computer program interaction style in terms of a student-oriented to presenter-oriented continuum?

24. A How would you characterize your interaction style with students in your normal classroom activities in terms of an open-ended to closed continuum?

25. A How would you characterize your interaction style in terms of a flexible presentation to strict flow continuum?

26. A How would you characterize your interaction style in terms of a friendly conversation to formal presentation continuum?

27. A How would you characterize your interaction style in terms of a student-oriented to presenter-oriented continuum?

28. U What percentage of your computer use in the classroom is as the object--or learning about the computer--of instruction?

29. U What percentage of your computer use in the classroom is as the means—or learning through the computer—of instruction?

30. U What types of instructional programs do you use on the computer (problem solving, tutorial, drill and practice, dialog, managing instruction, student programming, simulation and games, diagnostic and testing, problem generator, inquiry)?

31. U What percentage of the programs you write for the computer present material only?

32. U What percentage of the programs that you write for the computer react to student input?

33. U What percentage of the programs you write for the computer adapt using student history as well as responses?

34. A Have you any computer programs in mind that you have not yet implemented?

35. Y What are they?

36. Y What would enable you to write them?

37. A How many computer programs for instruction, total, do you know that you have available for your use?

38. A What computer languages do you know?

39. U What languages do you use for writing programs?

40. Y How long have you been programming with (language)?

41. Y How many programs have you written with (language)?

42. A What portion of your community do you feel is aware of the computer as an instructional medium?

43. A Do you feel the reaction of those who are aware of the use of the computer as an instructional medium is very positive, just positive, neutral, negative, or very negative?

44. A What portion of the administration do you feel is aware of the computer as an instructional medium?

45. A Do you feel the reaction of the aware administrators is very positive, positive, neutral, negative, or very negative?

46. A What portion of the other teachers do you feel is aware of the computer as an instructional medium?

47. A Do you feel the reaction of the aware teacher is very positive, positive, neutral, negative, or very negative?

48. A What portion of the staff do you feel is aware of the computer as an instructional medium?

49. A Where do you feel their reaction to the computer fits on the very positive to very negative line?

50. A What portion of the students do you feel is aware of the use of the computer as an instructional medium?

51. A Where do you feel the aware student reaction to the computer fits on the very positive to very negative line?

52. A Do you see any possibility for recognition as a result of using the computer?

53. Y What?

54. D What would enable you to use the computer in instruction?

55. A What educational impact do you feel that the computer can have?

56. A If you were given anything you needed in terms of time, money, and equipment in order to use the computer as an instructional aid, how would you use it?

57. A What question did you note that seemed exceptionally good, if any?

58. A What question did you note that seemed exceptionally poor, if any?

59. A Were there any questions that you expected that weren't included?

60. Y What were they?

61. A Are there any questions that need to be added?

62. Y What are they?

ADMINISTRATION INTERVIEW:

The purpose of this interview is to determine what factors may have an affect on the use of the computer as an instructional medium in the classroom. The use of the computer as an instructional aid refers to the application of the computer to the instructional process as a tool for aiding the teacher in the presentation of course material.

Answer the following questions to the best of your knowledge at this time.

1. What computer equipment do you have in your school system?
2. What percentage of the capacity of your computer is being used?
3. What equipment (hardware) is made available for instructional use?
4. How much of the equipment made available for instructional use is not used?
5. What of that equipment not currently used for instruction could be made usable for instruction?
6. How long, on the average, does a user have to wait for results after presenting a program to the computer from a terminal?
7. How long, on the average, does a user have to wait for results after presenting a program to the computer in the batch system?
8. What is the difference in terms of waiting time among various types of users?
9. What type of input and output devices are normally available for a teacher using the computer?
10. What additional types of input and output devices do you have that could be used for instruction
11. What are the operational hours of the computer for teachers?
12. When is the computer not available for teachers?
13. What kinds of assistance does a teacher have in developing and producing a program for instruction by computer?
14. What restrictions are placed on a teacher wishing to use the computer?
15. How much active space is normally available for teachers using a terminal?

16. How much on-line storage space is available on the computer for teachers?

17. How much can any one teacher store for immediate use (on-line) on the computer?

18. How fast is the computer access time for normal runs?

19. How fast is the computer access time for teacher runs?

20. In general, what computer languages do the teachers know or use?

21. What languages are available for the teachers to use?

22. How many programs are available for teachers to use?

23. How many programs are normally available on the terminal for teacher use?

24. How many programs are available for a teacher on-line?

25. How fast can computer-ready programs that aren't implemented be made available for teachers to use?

26. How much money is allocated to the use of the computer as an instructional medium?

27. What percentage of your computer utilization is administrative?

28. What percentage of your computer utilization is instructional?

29. What question did you note that seemed exceptionally good, if any?

30. What question did you note that seemed exceptionally poor, if any?

31. What questions did you expect that weren't included, if any?

32. What questions need to be added, if any?

APPENDIX B

INITIAL QUESTIONNAIRE

QUESTIONNAIRE

In answering this questionnaire, use your current situation and answer the questions as if you were going to receive a computer within a few weeks. Please indicate a position on the continuum with a mark or a number, whichever you desire.

1.	How many students do you teach per day?	0 75 150
2.	How many class periods do you teach per day?	0 4 8
3.	How many hours of release time (planning period, etc.) do you currently receive per month?	0 25 50
4.	How many hours have you spent using the computer?	0 50 100
5.	How many hours have you spent using the computer in instruction?	0 50 100
6.	How many people do you know who make use of the computer for any purpose?	0 10 25 50
7.	How many people do you know who make use of the computer in instruction?	0 10 25 50
8.	For how many years have you known how to program a computer?	0 5 10
9.	How many classes would you use the computer in?	0 4 8
10.	How many students would you expect to use the computer for your classes?	0 75 150
11.	How many computer programs do you know of that you would use in your classes?	0 50 100
12.	How many programs would you like to write for your students to use?	0 25 50
13.	How many programs would you like to have someone else write for your instructional use?	0 25 50
14.	How many hours of use would you make of a batch processing system per day?	0 5 50
15.	How many hours of use would you make of an interactive terminal type of processing per day?	0 5 10

16. How many hours per day would you expect that you would use the computer before or after school hours? 0 4 8

17. How many hours per day would you predict that your students would use the computer before or after school hours? 0 4 8

18. How many programs would you store on the computer for instructional use? 0 10 50 150

19. How many hours per week would you and your students make use of the computer for the following?

Instruction	0 5 20
Testing	0 5 20
Drill and practice	0 5 20
Managing instruction	0 5 20
Statistical analysis	0 5 20
Experimenting	0 5 20
Problem solving	0 5 20
Student programming	0 5 20
Presenting material	0 5 20
Interaction with material	0 5 20
Simulation and games	0 5 20
Problem generation	0 5 20
Information retrieval for inquiry	0 5 20
Other_____	0 5 20

20. How much assistance would you need in the following during the year after a computer became available for your use?

	day	week	month	year	cont
Learning to program					
Writing programs					
Designing instruction					
Implementing programs					

21. What do you feel is the level of awareness (percentage) of the following to the use of the computer as an instructional medium?

	0	50	100
Administration			
Teachers			
Students			
Community			

22. What do you feel is the general attitude of the following to the use of the computer as an instructional medium?

	v.neg.	neut.		v.pos.
Administration				
Teachers				
Students				
Community				

APPENDIX C

QUESTIONNAIRE

QUESTIONNAIRE

In answering this questionnaire, use your current situation and answer the questions as if you were going to have access to a computer soon. Please indicate a position on the continuum with a mark. If you have no answer to a question, mark beside the zero (0) box. The starred (*) words are defined in the glossary.

1. Mark the subjects you teach with a "T".
2. Mark the subjects in which you feel the computer should be used with a "C".

Mathematics			Social studies		
Fine arts			Science		
Language			Physical education		
Foreign language			Counseling		
Business			Vocational program		
Industrial arts			Career education		
Basic skills					
3. How many students do you teach per day?	0-75	76-100	101-126	126-150	More
4. How many class periods do you teach per day?	0, 1	2, 3	4, 5	6, 7	More
5. What grade levels do you teach?	K-5	6,7	8,9	10-12	Univ.
6. How many hours of release time (planning period, etc.) do you currently receive per month?	0-15	16-25	26-35	36-50	More
7. How many hours have you spent using the computer in instruction?	0-25	26-50	51-75	76-100	More
8. How many hours have you spent using the computer?	0-25	26-50	51-75	76-100	More
9. How many people do you know who make direct use of the computer for any purpose?	0-15	16-25	26-35	36-50	More
10. What is their attitude toward using the computer?	—	-	n	+	++ *
11. How many people do you know who use the computer in instruction?	0-15	16-26	26-36	36-50	More

12. What is their attitude toward using the computer?	—	-	n	+	++ *
13. What is your impression of the use of the computer as an instructional medium?	—	-	n	+	++ *
14. For how many years have you known a computer programming* language?	0-2	3-5	6-8	9, 10	More
15. In how many classes would you use the computer?	0, 1	2, 3	4, 5	6, 7	More
16. How many students would you expect to use the computer for your classes?	0-75	76-100	101-125	126-150	More
17. How many computer programs* do you know of that you would use in your classes?	0-25	26-50	51-75	76-100	More
18. How many computer programs* would you like to write for your students to use?	0-25	26-50	51-75	76-100	More
19. How many programs* would you like to have someone else write for your instructional use?	0-25	26-50	51-75	76-100	More
20. How many hours of use would you and your students make of a batch processing* system per day?	0-2	3-5	6-8	9, 10	More
21. How many hours of use would you and your students make of an interactive terminal* type of processing per day?	0-2	3-5	6-8	9, 10	More
22. How many hours per day would you expect that you would use the computer before and after school hours?	0, 1	2, 3	4, 5	6, 7	More
23. How many hours per day would you predict that your students would use the computer voluntarily, on the average, before and after school hours?	0, 1	2, 3	4, 5	6, 7	More

24. How many hours per week would you and your students make use of the computer for the following (see Glossary)?

	0-5	6-10	11-15	16-20	More
Instruction					
Presenting Material					
Interaction with material					
Drill and practice					
Problem generation					
Managing instruction	0-5	6-10	11-15	16-20	More
Testing and grading					
Experimenting					
Student programming					
Simulation					
Games	0-5	5-10	11-15	16-20	More
Inquiry					
Other_____					

25. How many programs would you store* on the computer for instructional use?

0-75	76-100	101-125	126-150	More

26. How much assistance would you need in the following during the year after a computer became available for your use?

	In-service (How long?)	Consultation (How much?)
Learning to program	days	hrs/wk
Writing programs	days	hrs/wk
Designing instruction	days	hrs/wk
Implementing programs	days	hrs/wk

27. What do you feel is the level of awareness* of the following to the use of the computer as an instructional medium?

Administration _____% Teachers _____%

Students _____% Community _____%

28. What do you feel is the general attitude of the following to the use of the computer as an instructional medium?

Administration	—	-	n	+	++
Teachers	—	-	n	+	++
Students	—	-	n	+	++
Community	—	-	n	+	++

GLOSSARY

Since the use of the computer in instruction may be a new concept for you, this glossary is provided to assist you with the terms that might be unclear in the questionnaire.

-- - n + ++: this continuum runs from very negative through negative, neutral, and positive to very positive.

Batch processing: a bunch of programs are collected and given to the computer at one time.

Drill and practice: using the computer to give drill or practice items for the student to use.

Experimenting: trying out things using the computer, including research.

Games: the computer can serve as a mediator in a complicated game or as an opponent in a game.

Inquiry: information is given to the student in order for the student to develop a concept.

Instruction: using the computer in any way to help in the instructional process.

Interaction with material: using the computer to react to what the user inputs.

Interactive terminal: immediate interaction with the computer through a typewriter-like input and output device.

Level of awareness: the average knowledge of the computer as an instructional medium held by a group.

Managing instruction: using the computer to analyze information about students and materials to determine what would be best for the student to interact with next.

Presenting material: using the computer to present information to users.

Problem generation: the computer can generate problems given certain information about the desired problems.

Programs: a description of a problem or idea in terms that the computer can understand.

Programming: writing a computer program*.

Simulation: using the computer to act as a model of some real or theoretical object or concept.

Store: the way a computer remembers is called "store."

Student programming: students write programs* that use the computer.

Testing and grading: using the computer to give and grade tests. It could select items, analyze answers, etc.

VITA

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